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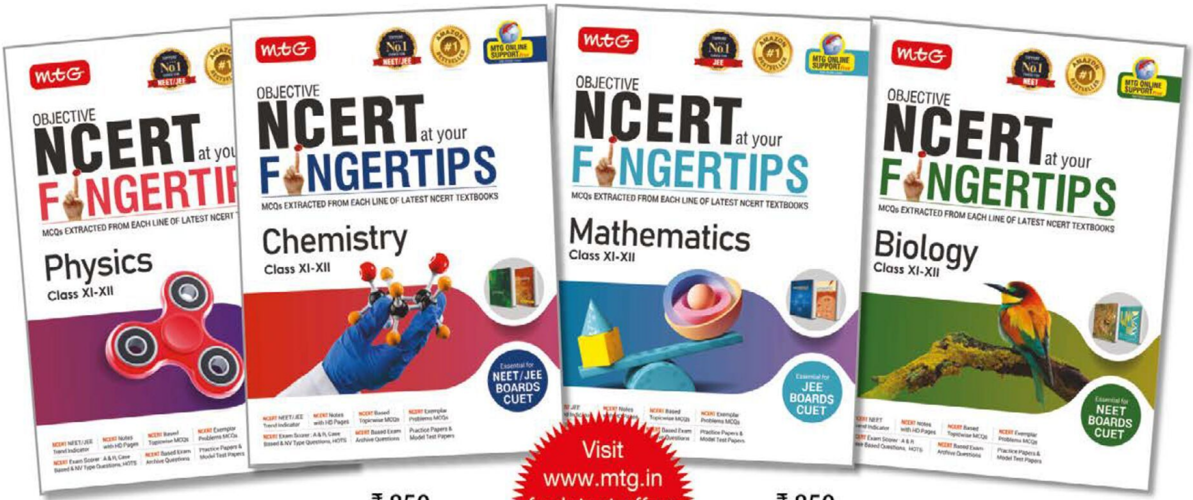
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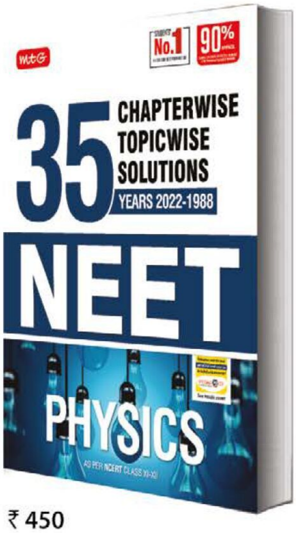
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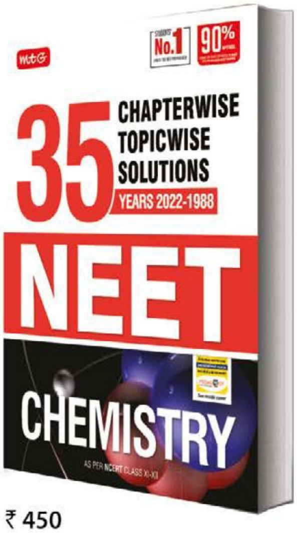
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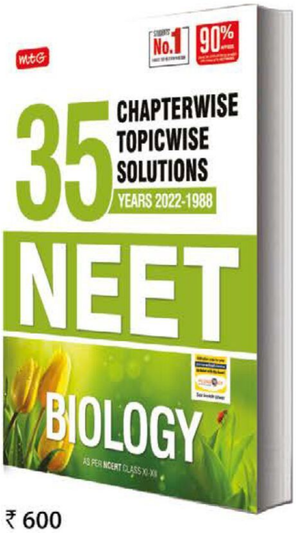
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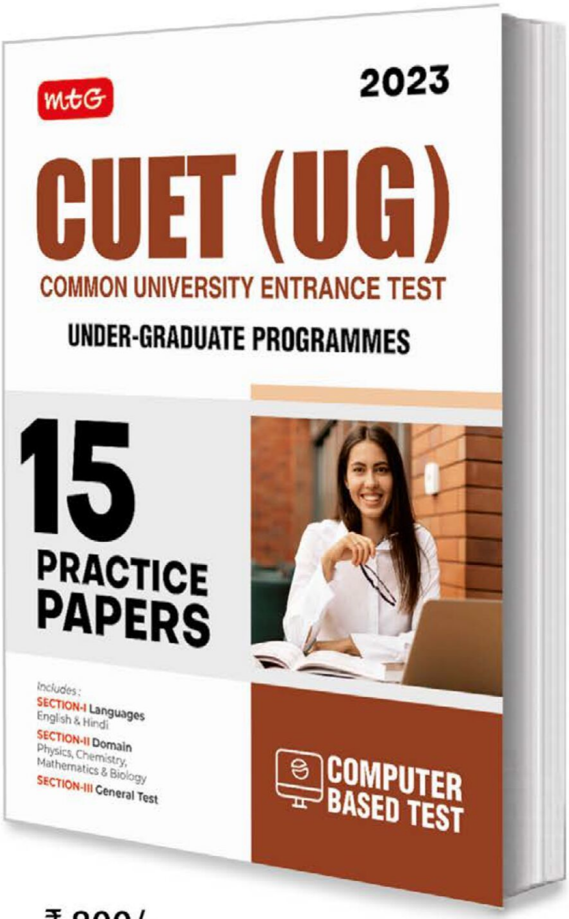
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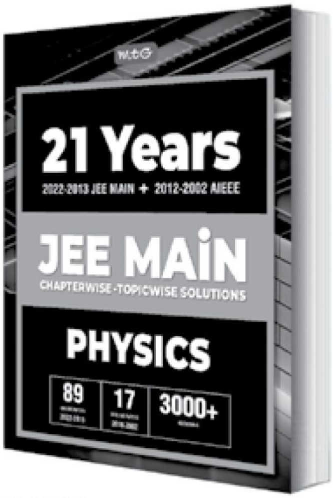

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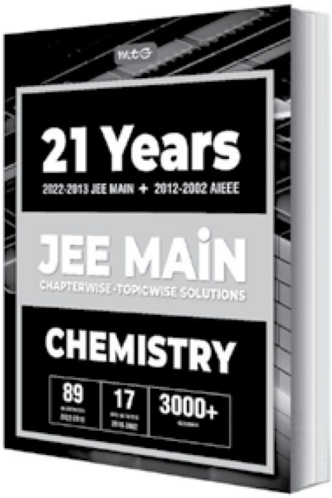

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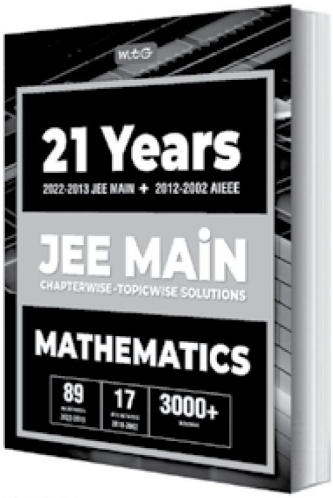

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Held on
24th Jan, Morning Shift
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JEE MAIN 2023

SECTION-A (MULTIPLE CHOICE QUESTIONS)

1. In the depression of freezing point experiment
A. vapour pressure of the solution is less than that of pure solvent
B. vapour pressure of the solution is more than that of pure solvent
C. only solute molecules solidify at the freezing point
D. only solvent molecules solidify at the freezing point.
Choose the most appropriate answer from the options given below.
(a) A only (b) B and C only
(c) A and C only (d) A and D only

2. Order of covalent bond :
A. KF > KI ; LiF > KF
B. KF < KI ; LiF > KF
C. $SnCl_4 > SnCl_2$; CuCl > NaCl
D. LiF > KF ; CuCl < NaCl
E. KF < KI ; CuCl > NaCl
Choose the correct answer from the options given below.
(a) A, B only (b) B, C only
(c) B, C, E only (d) C, E only

3. Match List I with List II.

List I		List II	
(A)	Reverberatory furnace	I.	Pig iron
(B)	Electrolytic cell	II.	Aluminium
(C)	Blast furnace	III.	Silicon
(D)	Zone refining furnace	IV.	Copper

Choose the correct answer from the options given below.
(a) (A) → I ; (B) → III ; (C) → II ; (D) → IV
(b) (A) → III ; (B) → IV ; (C) → I ; (D) → II
(c) (A) → I ; (B) → IV ; (C) → II ; (D) → III
(d) (A) → IV ; (B) → II ; (C) → I ; (D) → III

4. Which of the following is true about freons?
(a) These are radicals of chlorine and chlorine monoxide.
(b) These are chlorofluorocarbon compounds.
(c) All radicals are called freons.
(d) These are chemicals causing skin cancer.

5. Match List I with List II.

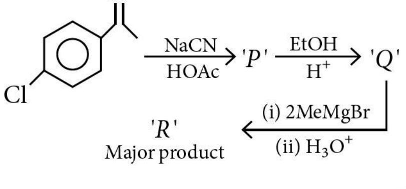
List I		List II	
(A)	Chlorophyll	I.	Na_2CO_3
(B)	Soda ash	II.	$CaSO_4$
(C)	Dentistry, Ornamental work	III.	Mg^{2+}
(D)	Used in white washing	IV.	$Ca(OH)_2$

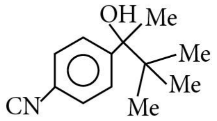
Choose the correct answer from the options given below.
(a) (A) → III ; (B) → I ; (C) → II ; (D) → IV
(b) (A) → II ; (B) → III ; (C) → IV ; (D) → I
(c) (A) → III ; (B) → IV ; (C) → I ; (D) → II
(d) (A) → II ; (B) → I ; (C) → III ; (D) → IV

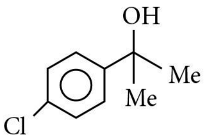
6. The magnetic moment of a transition metal compound has been calculated to be 3.87 B.M. The metal ion is
(a) Ti^{2+} (b) Mn^{2+} (c) V^{2+} (d) Cr^{2+}

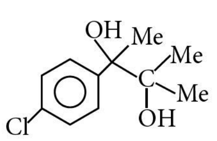
7. Decreasing order of the hydrogen bonding in following forms of water is correctly represented by
A. Liquid water B. Ice C. Impure water
Choose the correct answer from the options given below.
(a) C > B > A (b) B > A > C
(c) A = B > C (d) A > B > C

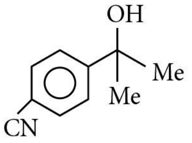
8. '*R*' formed in the following sequence of reactions is



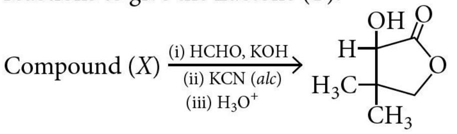
(a) 

(b) 

(c) 

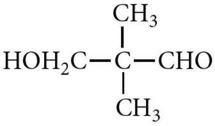
(d) 

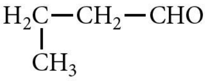
9. Compound (*X*) undergoes following sequence of reactions to give the Lactone (*Y*).

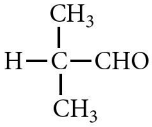


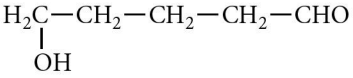
Lactone (*Y*)

Compound (*X*) is

(a) 
$HOH_2C-\underset{CH_3}{\overset{CH_3}{C}}-CHO$

(b) 
$H_2\underset{CH_3}{C}-CH_2-CHO$

(c) 
$H-\underset{CH_3}{\overset{CH_3}{C}}-CHO$

(d) 
$H_2\underset{OH}{C}-CH_2-CH_2-CH_2-CHO$

10. An ammoniacal metal salt solution gives a brilliant red precipitate on addition of dimethylglyoxime. The metal ion is

(a) Co^{2+} (b) Fe^{2+} (c) Ni^{2+} (d) Cu^{2+}

11. Reaction of BeO with ammonia and hydrogen fluoride gives *A* which on thermal decomposition gives BeF_2 and NH_4F. What is '*A*'?

(a) $(NH_4)BeF_3$ (b) H_3NBeF_3
(c) $(NH_4)Be_2F_5$ (d) $(NH_4)_2BeF_4$

12. **Assertion A :** Hydrolysis of an alkyl chloride is a slow reaction but in the presence of NaI, the rate of the hydrolysis increases.

Reason R : I^- is a good nucleophile as well as a good leaving group.

In the light of the above statements, choose the correct answer from the options given below.

(a) A is false but R is true.
(b) Ais true but R is false.
(c) Both A and R are true but R is not the correct explanation of A.
(d) Both A and R are true and R is the correct explanation of A .

13. Given below are two statements :

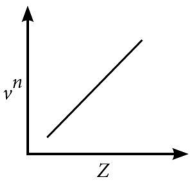
Statement I : Noradrenaline is a neurotransmitter.

Statement II : Low level of noradrenaline is not the cause of depression in human.

In the light of the above statements, choose the correct answer from the options given below.

(a) Statement I is incorrect but statement II is correct.
(b) Both statement I and statement II are correct.
(c) Statement I is correct but statement II is incorrect.
(d) Both statement I and statement II are incorrect.

14. It is observed that characteristic X-ray spectra of elements show regularity. When frequency to the power "*n*" *i.e.* v^n of X-rays emitted is plotted against atomic number "*Z*", following graph is obtained.



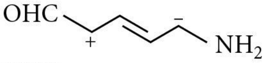
The value of "*n*" is

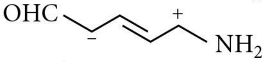
(a) 2 (b) 3 (c) 1 (d) 1/2

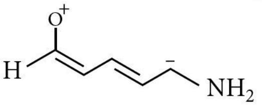
15. Which of the phosphorus oxoacid can create silver mirror from $AgNO_3$ solution?

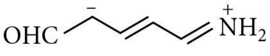
(a) $H_4P_2O_7$ (b) $(HPO_3)_n$
(c) $H_4P_2O_6$ (d) $H_4P_2O_5$

16. Increasing order of stability of the resonance structure is

(A) 

(B) 

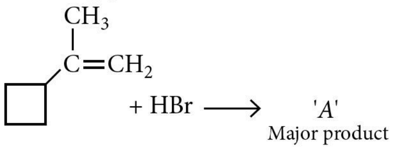
(C) 

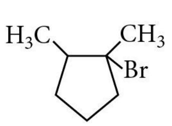
(D) 

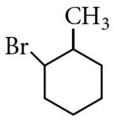
Choose the correct answer from the options given below.

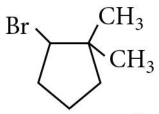
(a) D, C, A, B (b) C, D, B, A
(c) D, C, B, A (d) C, D, A, B

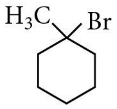
17. In the following given reaction, '*A*' is



(a) 

(b) 

(c) 

(d) 

18. The primary and secondary valencies of cobalt respectively in $[Co(NH_3)_5Cl]Cl_2$ are

(a) 3 and 5
(b) 2 and 6
(c) 2 and 8
(d) 3 and 6

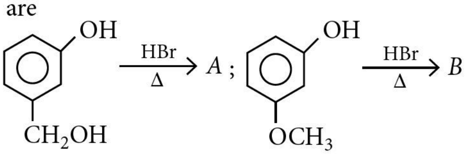
19. **Statement I :** For colloidal particles, the values of colligative properties are of small order as compared to values shown by true solutions at same concentration.

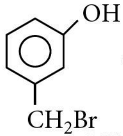
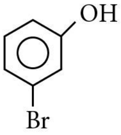
Statement II : For colloidal particles, the potential difference between the fixed layer and the diffused layer of same charges is called the electrokinetic potential or zeta potential.

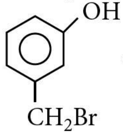
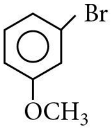
In the light of the above statements, choose the correct answer from the options given below.

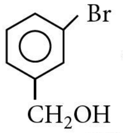
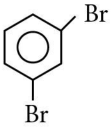
(a) Statement I is false but statement II is true.
(b) Both statement I and statement II are true.
(c) Statement I is true but statement II is false.
(d) Both statement I and statement II are false.

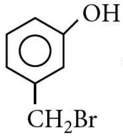
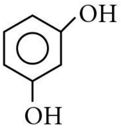
20. '*A*' and '*B*' formed in the following set of reactions are



(a) $A =$ , $B =$ 

(b) $A =$ , $B =$ 

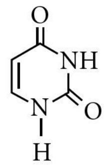
(c) $A =$ , $B =$ 

(d) $A =$ , $B =$ 

SECTION - B (NUMERICAL VALUE TYPE)

Attempt any 5 questions out of 10.

21. Uracil is a base present in RNA with the following structure. % of N in uracil is ______.



Given : Molar mass N = 14 g mol^{-1}
O = 16 g mol^{-1}
C = 12 g mol^{-1}
H = 1 g mol^{-1}.

22. If wavelength of the first line of the Paschen series of hydrogen atom is 720 nm, then the wavelength of the second line of this series is ______ nm. (Nearest integer)

23. At 298 K, a 1 litre solution containing 10 mmol of $Cr_2O_7^{2-}$ and 100 mmol of Cr^{3+} shows a pH of 3.0.
Given : $Cr_2O_7^{2-} \longrightarrow Cr^{3+}$; $E° = 1.330$ V

and $\dfrac{2.303\,RT}{F} = 0.059$ V

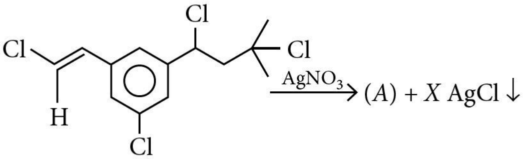
The potential for the half cell reaction is $x \times 10^{-3}$ V. The value of x is ______.

24. The dissociation constant of acetic acid is $x \times 10^{-5}$. When 25 mL of 0.2 M CH_3COONa solution is mixed with 25 mL of 0.02 M CH_3COOH solution, the pH of the resultant solution is found to be equal to 5. The value of x is ______.

25. For independent processes at 300 K, the number of non-spontaneous processes from the following is ______.

Process	ΔH/kJ mol^{-1}	ΔS/J K^{-1}
A	–25	–80
B	–22	40
C	25	–50
D	22	20

26. Number of moles of AgCl formed in the following reaction is ______.



27. The *d*-electronic configuration of $[CoCl_4]^{2-}$ in tetrahedral crystal field is $e^m t_2^n$. Sum of "*m*" and "number of unpaired electrons" is ______.

28. 5 g of NaOH was dissolved in deionized water to prepare a 450 mL stock solution. What volume (in mL) of this solution would be required to prepare 500 mL of 0. 1 M solution?
Given : Molar mass of Na, O and H is 23, 16 and 1 g mol^{-1} respectively.

29. The number of correct statement/s from the following is ______.

A. Larger the activation energy, smaller is the value of the rate constant.

B. The higher is the activation energy, higher is the value of the temperature coefficient.

C. At lower temperatures, increase in temperature causes more change in the value of k than at higher temperature.

D. A plot of $\ln k$ vs $\frac{1}{T}$ is a straight line with slope equal to $-\frac{E_a}{R}$.

30. When $Fe_{0.93}O$ is heated in presence of oxygen, it converts to Fe_2O_3. The number of correct statement/s from the following is ______.

A. The equivalent weight of $Fe_{0.93}O$ is $\frac{\text{Molecular weight}}{0.79}$

B. The number of moles of Fe^{2+} and Fe^{3+} in 1 mole of $Fe_{0.93}O$ is 0. 79 and 0.14 respectively.

C. $Fe_{0.93}O$ is metal deficient with lattice comprising of cubic closed packed arrangement of O^{2-} ion.

D. The % composition of Fe^{2+} and Fe^{3+} in $Fe_{0.93}O$ is 85% and 15% respectively.

SOLUTIONS

1. (d): In the depression of freezing point experiment, only solvent molecules solidify and vapour pressure of solution decreases as some of the surface area is occupied by solute molecules, so less number of molecules will go in vapour form.

2. (c) : Covalent character depends on the charge and size of the ions. Smaller the cation, greater is the polarisation, more will be the covalent character and larger the anion, greater will be the polarisation, more will be the covalent character.

As the charge on the cation or anion increases, covalent character also increases.

KF < KI, since I^- has larger size than F^-.

LiF > KF, since Li^+ has smaller size than K^+.

$SnCl_4 > SnCl_2$, since Sn^{4+} has more positive charge than Sn^{2+}, so, attracts electronic cloud more towards itself.

CuCl > NaCl, since Cu^+ has smaller size than Na^+.

So, the correct options are B, C, E only.

3. (d): Extraction of copper is done in reverberatory furnace.

Electrolytic cell is used for extraction of alumunium.

Blast furnace is used for pig iron.

Zone refining is used for purification of silicon.

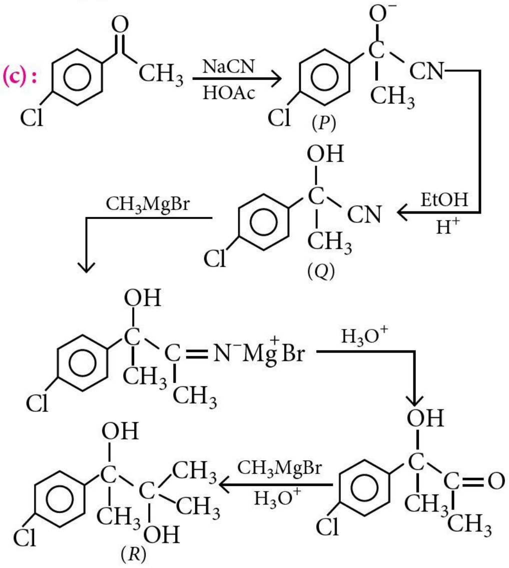
4. (b)

5. (a) : A - III, B - I, C - II, D - IV

6. (c) : V^{2+} has outer electronic configuration as $3d^3\,4s^0$. So, it has 3 unpaired electrons which gives a magnetic moment of 3.87 B.M.

7. (b): Ice has more complexed hydrogen bonding than liquid water while in impure water, hydrogen bonding gets disturbed.

8. (c):



9. (c)

10. (c) : $Ni^{2+} + \text{dmg} + NH_4OH \longrightarrow \underset{\text{(Red ppt.)}}{[Ni(dmg)_2]\downarrow} + NH_4^+ + H_2O$

11. (d): $BeO + 2NH_3 + 4HF \longrightarrow \underset{(A)}{(NH_4)_2BeF_4} \xrightarrow{\Delta} BeF_2 + 2NH_4F$

12. (d) **13. (c)**

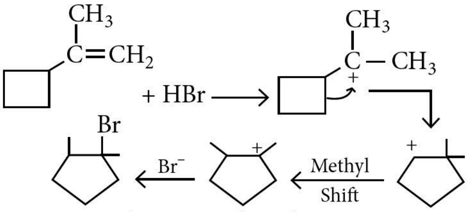
14. (d): The relation between the atomic number and frequency for the X-rays is given as $\nu^{1/2} \propto Z$

$\therefore \quad n = 1/2$

15. (d): As it contains two P—H bonds, so it can reduce $AgNO_3$ to Ag.

16. (d): The increasing order of stability of given resonance structures is C < D < A < B.

17. (a) :

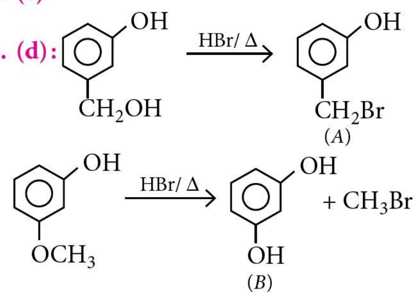


18. (d): Primary valency is the charge on central metal ion. So, it is 3 while secondary valency is the number of ligands in the complex *i.e.*, 6.

$[Co(NH_3)_5Cl]Cl_2 : x + 5(0) - 1 = +2 \Rightarrow x = +3$

19. (c)

20. (d):



21. (25)

22. (492) : For first line : $n_1 = 3, n_2 = 4$

For second line : $n_1 = 3, n_2 = 5$

For H-atom, $\frac{1}{\lambda_1} = \frac{1}{720} = R_H \times \left(\frac{1}{3^2} - \frac{1}{4^2}\right)$

or $\frac{1}{720} = R_H \times \frac{7}{9 \times 16}$ ...(i)

$\frac{1}{\lambda_2} = R_H \times \left(\frac{1}{3^2} - \frac{1}{5^2}\right)$ or $\frac{1}{\lambda_2} = R_H \times \frac{16}{9 \times 25}$ ...(ii)

Dividing eqn (i) by eqn. (ii),

$$\frac{1}{720} \times \frac{\lambda_2}{1} = \frac{7}{9 \times 16} \times \frac{25 \times 9}{16}$$

$$\lambda_2 = \frac{7 \times 25 \times 9 \times 720}{9 \times 16 \times 16} = 492.18 \text{ nm}$$

23. (917) : The half cell reaction is

$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O \ (\because n = 6)$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log \frac{[Cr^{3+}]^2}{[Cr_2O_7^{2-}][H^+]^{14}}$$

$pH = 3 \Rightarrow [H^+] = 10^{-3}$ M

$[Cr^{3+}] = 100 \text{ mmol/L} = 100 \times 10^{-3} \text{ mol/L}$
$= 10^{-1} \text{ mol/L}$

$[Cr_2O_7]^{2-} = 10 \text{ mmol/L} = 10 \times 10^{-3} \text{ mol/L}$
$= 10^{-2} \text{ mol/L}$

$$E_{cell} = 1.330 - \frac{0.059}{6} \times \log \frac{[10^{-1}]^2}{[10^{-2}][10^{-3}]^{14}}$$

$$= 1.330 - \frac{0.059}{6} \times 42 \log 10$$

$\Rightarrow E_{cell} = 0.917 \text{ V} = 917 \times 10^{-3} \text{ V}$

24. (10) : It is an acidic buffer solution.

$pH = pK_a + \log\frac{[Salt]}{[Acid]}$ or $5 = pK_a + \log\frac{25 \times 0.2}{25 \times 0.02}$

or $5 = pK_a + \log 10$

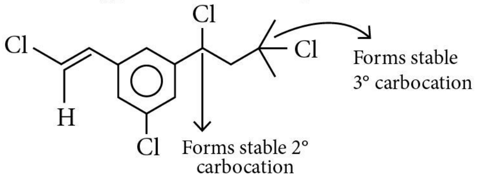
or $pK_a = 5 - \log 10 = 5 - 1 = 4$

$\because K_a = 10^{-4} = 10 \times 10^{-5}$

25. (2): $\Delta G = \Delta H - T\Delta S$

Process *A* and process *B* are spontaneous as $\Delta G = -ve$, while process *C* and process *D* are non-spontaneous.

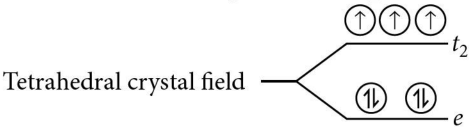
26. (2): There are only two replaceable Cl^- ions which form white ppt. of AgCl with $AgNO_3$.



27. (7): $[CoCl_4]^{2-} \Rightarrow$ oxidation state of Co is +2.

So, the electronic configuration is $3d^7\,4s^0$.

The *d*-electronic configuration is $e^4t_2^3$.



Sum of '*m*' and 'unpaired electrons' = 4 + 3 = 7

28. (180) : 5 g of NaOH, $n = \frac{5}{40}$ mol

$$M = \frac{5}{40} \times \frac{1}{450} \times 1000 = 0.278 \text{ M}$$

For 500 mL of 0.1 M solution,

$0.278 \times V = 500 \times 0.1$

$$V = \frac{500 \times 0.1}{0.278} \approx 180 \text{ mL}$$

29. (3): According to Arrhenius equation, $k = Ae^{-\frac{E_a}{RT}}$

$\ln k = -\frac{E_a}{RT} + \ln A \Rightarrow \text{Slope} = -\frac{E_a}{R}$

As the value of E_a increases, rate constant decreases.

As the value of E_a increases, value of temperature coefficient increases.

For every 10°C rise in temperature, rate constant is doubled.

So, statements A, B and D are correct.

30. (4)

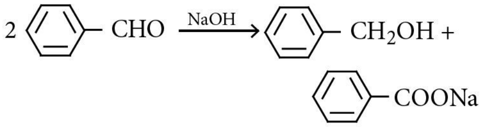
◆ ◆

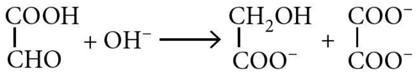
PRACTICE PAPER 2023
JEE MAIN

Exam Dates
Session-2
06, 08, 10, 11, 12 April 2023

SECTION-A (MULTIPLE CHOICE QUESTIONS)

1. Which of the following is not a disproportionation reaction?

(a) 

(b) 
$\underset{\text{CHO}}{\overset{\text{COOH}}{|}} + OH^- \longrightarrow \underset{\text{COO}^-}{\overset{\text{CH}_2\text{OH}}{|}} + \underset{\text{COO}^-}{\overset{\text{COO}^-}{|}}$

(c) $NaH + H_2O \rightarrow NaOH + H_2$

(d) $3ClO^-_{(aq)} \rightarrow ClO^-_{3(aq)} + 2Cl^-_{(aq)}$

2. Which of the following compounds is most soluble?

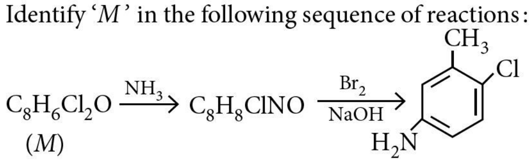
(a) Bi_2S_3 ($K_{sp} = 1 \times 10^{-70}$)

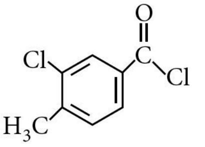
(b) MnS ($K_{sp} = 7 \times 10^{-16}$)

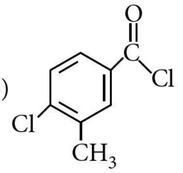
(c) CuS ($K_{sp} = 8 \times 10^{-37}$)

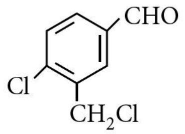
(d) Ag_2S ($K_{sp} = 6 \times 10^{-51}$)

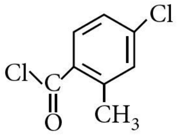
3. Identify '*M*' in the following sequence of reactions :



(a) 

(b) 

(c) 

(d) 

4. The uncertainty in the velocity of a cricket ball of mass 100 g, when uncertainty in its position is of the order of 1 Å, would be

(a) $\geq 5.27 \times 10^{-24}$ m s^{-1}

(b) $\geq 2.35 \times 10^{-23}$ m s^{-1}

(c) $\geq 3.16 \times 10^{-22}$ m s^{-1}

(d) $\geq 8.51 \times 10^{-24}$ m s^{-1}

5. Match the compounds given in List-I with List-II and select the suitable option.

	List-I		List-II
(A)	Benzaldehyde	(i)	Oil of wintergreen
(B)	Phthalic anhydride	(ii)	Benzoin condensation
(C)	Phenyl benzoate	(iii)	Phenolphthalein
(D)	Methyl salicylate	(iv)	Fries rearrangement

(a) (A)-(iv), (B)-(i), (C)-(iii), (D)-(ii)

(b) (A)-(iv), (B)-(ii), (C)-(iii), (D)-(i)

(c) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)

(d) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)

6. Low spin complex of d^6-cation in an octahedral field will have the following energy

(a) $\frac{-12}{5}\Delta_o + P$ (b) $\frac{-12}{5}\Delta_o + 3P$

(c) $\frac{-2}{5}\Delta_o + 2P$ (d) $\frac{-2}{5}\Delta_o + P$

(Δ_o = crystal field splitting energy in an octahedral field, P = Electron pairing energy)

7. The colour of $CuCr_2O_7$ solution in water is green because

(a) $Cr_2O_7^{2-}$ ions are green

(b) Cu^{2+} ions are green

(c) both $Cr_2O_7^{2-}$ and Cu^{2+} ions are green

(d) Cu^{2+} ions are blue and $Cr_2O_7^{2-}$ ions are yellow.

8. Phospholipids are esters of glycerol with

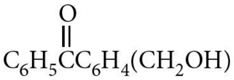
(a) three carboxylic acid residues

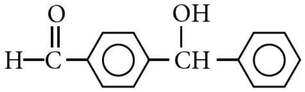
(b) two carboxylic acid residues and one phosphate group

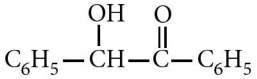
(c) one carboxylic acid residue and two phosphate groups

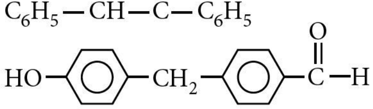
(d) three phosphate groups.

9. A substance (*A*), $C_{14}H_{12}O_2$ reacts with NH_2OH. It is reduced by $NaBH_4$ to give $C_{14}H_{14}O_2$ which is oxidised with HIO_4 to benzaldehyde . (*A*) is

(a) 
$C_6H_5\overset{\overset{O}{\parallel}}{C}C_6H_4(CH_2OH)$

(b) 

(c) 
$C_6H_5-\overset{\overset{OH}{|}}{CH}-\overset{\overset{O}{\parallel}}{C}-C_6H_5$

(d) 

10. An alkaline earth metal 'M' readily forms water soluble sulphate and water insoluble hydroxide, $M(OH)_2$. Its oxide, MO, is amphoteric, hard and possesses high melting point. The hydroxide is also amphoteric in nature. The alkaline earth metal 'M' must be

(a) Be (b) Mg (c) Ca (d) Ba

11. Given below are two statements: one is labelled as Assertion (A) and other is labelled as Reason (R).

Assertion (A) : Differential extraction is used for the separation of an organic compound from its aqueous solution.

Reason (R) : The solvent chosen should be miscible with water and should not dissolve the organic compound to be separated.

In the light of the above statements, choose the correct answer from the options given below :

(a) Both A and R are true and R is correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is false but R is true.
(d) A is true but R is false.

12. On complete combustion, 0.246 g of an organic compound gave 0.198 g of CO_2 and 0.1014 g of H_2O. The ratio of carbon and hydrogen atoms in the compound is

(a) 1 : 3 (b) 1 : 2 (c) 2 : 5 (d) 2 : 7

13. A chemical reaction proceeds following the formula $k = PZe^{-E_a/RT}$. Which of the following processes will increase the rate of reaction?

(a) Lowering of E_a
(b) Lowering of P
(c) Lowering of Z
(d) Independent of all the above factors.

14. Which of the following species will not exhibit disproportionation reaction?

(a) ClO^- (b) ClO_2^- (c) ClO_3^- (d) ClO_4^-

15. Acyclic stereoisomers having the molecular formula, C_4H_7Cl are classified and tabulated. Find out the correct set of numbers.

	Geometrical	Optical
(a)	6	2
(b)	4	2
(c)	6	0
(d)	4	0

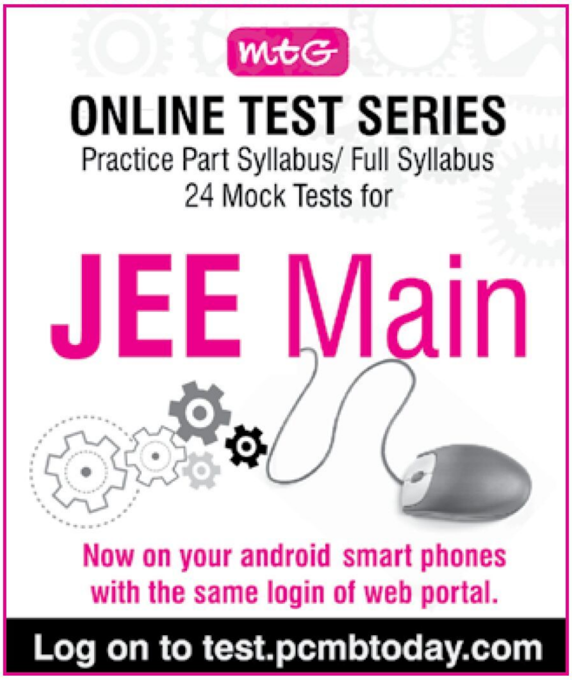
16. **Statement I :** Molecular nitrogen is less reactive than molecular oxygen.

Statement II : The bond length of N_2 is shorter than that of oxygen.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement II is correct but statement I is incorrect.

17. Match the terms given in Column I with the units given in Column II and select the correct option.

Column I		Column II	
(i)	Λ_m	(P)	S cm^{-1}
(ii)	E_{cell}	(Q)	ohm m
(iii)	κ	(R)	S cm^2 mol^{-1}
(iv)	ρ	(S)	V


MTG
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(a) (i) → (R); (ii) → (S); (iii) → (P); (iv) → (Q)
(b) (i) → (R); (ii) → (P); (iii) → (S); (iv) → (Q)
(c) (i) → (P); (ii) → (S); (iii) → (R); (iv) → (Q)
(d) (i) → (P); (ii) → (Q); (iii) → (R); (iv) → (S)

18. One mole of a non-ideal gas undergoes a change of state (2.0 atm, 3.0 L, 95 K) $\rightarrow$ (4.0 atm, 5.0 L, 245 K) with a change in internal energy, $\Delta U = 30.0$ L atm. The change in enthalpy (ΔH) of the process in L atm is
(a) 40.0
(b) 42.3
(c) 44.0
(d) not defined, because pressure is not constant.

19. The open chain glucose and fructose have _______ and _______ chiral centres respectively.
(a) 4, 4 (b) 4, 3 (c) 3, 3 (d) 3, 4

20. The group of synthetic rubber polymers is
(a) Buna-S, Gutta-Percha, Teflon
(b) Buna-S, Neoprene, Orlon
(c) Neoprene, Buna-S, Buna-N
(d) Orlon, Neoprene, Gutta-Percha.

SECTION-B (NUMERICAL TYPE QUESTIONS)

Attempt any 5 questions out of 10.

21. K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is _____.

22. What is the pH of a 0.5 M aqueous solution of NH_4Cl with 0.2 M NH_3? ($pK_a = 9.25$)

23. The number of electrons involved in the reduction of nitrate ion to hydrazine is _____.

24. The number of paramagnetic complexes among the following is ________.

$[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$, $[Fe(CN)_6]^{4-}$, $[Cu(NH_3)_4]^{2+}$, $[Fe(CN)_6]^{3-}$, $[Fe(H_2O)_6]^{2+}$

25. A quantity of PCl_5 was heated in a 10 dm^3 vessel at 250°C:

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

At equilibrium, the vessel contains 0.1 mole of PCl_5 and 0.2 mole of Cl_2. The equilibrium constant of the reaction is___.

26. $2Hg \rightarrow Hg_2^{2+}$, $E° = -0.799$ V
$Hg \rightarrow Hg^{2+}$, $E° = -0.855$ V
Equilibrium constant for the reaction
$Hg + Hg^{2+} \rightarrow Hg_2^{2+}$ at 27°C is_____.

27. Among the following, the correct statement(s) is/are _______ .

I. Vacancy defect leads to decrease in density of substance.
II. The packing efficiency of *bcc* structure is 52.4%.
III. In metal excess defect, the cationic sites are occupied by *F*-centres.
IV. O_2 and Cr^{3+} are examples of paramagnetic species.
V. The formula of compound is X_4Y_3, if Y occupies *hcp* lattice and X occupies $\frac{2}{3}$rd of tetrahedral voids.

28. The number of reaction(s) used in the preparation of alcohols is/are______.

(i) Chlorination of toluene followed by hydrolysis.
(ii) Reduction of nitriles.
(iii) Reaction of carbonyl compound with grignard reagent.
(iv) Reduction of carbonyl compound by Zn-Hg/HCl.
(v) Hydration of alkenes.

29. Optical activity of an enantiomeric mixture is +12.6° and the specific rotation of (+) isomer is +30°. The optical purity is _______%.

30. Consider the following reactions,

$$A \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } CH_3MgBr} B \xrightarrow[573\text{ K}]{Cu} \text{2-Methyl-2-butene}$$

The mass percentage of carbon in A is _____.

SOLUTIONS

1. **(c) :** The reaction $\overset{+1}{Na}\overset{-1}{H} + \overset{+1}{H_2}\overset{-2}{O} \longrightarrow \overset{+1}{Na}\overset{-2}{O}\overset{+1}{H} + \overset{0}{H_2}$, is not a disproportionation reaction because in disproportionation reaction same substance undergoes oxidation and reduction simultaneously.

2. **(b):** (i) Let solubility be s. Greater the value of s, greater is the solubility of salt.

$$\underset{(s)}{Bi_2S_3} \rightleftharpoons \underset{(2s)}{2Bi^{3+}} + \underset{(3s)}{3S^{2-}}$$

$$K_{sp} = (2s)^2(3s)^3 = 108\,s^5 \Rightarrow 108\,s^5 = 10^{-70}$$

$$s = \left(\frac{10^{-70}}{108}\right)^{1/5} = 3.9 \times 10^{-15}\text{ M}$$

(ii) $\underset{(s)}{MnS} \rightleftharpoons \underset{(s)}{Mn^{2+}} + \underset{(s)}{S^{2-}}$

$$K_{sp} = (s)(s)$$

$$s = \sqrt{7 \times 10^{-16}} = 2.6 \times 10^{-8}\text{ M}$$

(iii) $\underset{(s)}{CuS} \rightleftharpoons \underset{(s)}{Cu^{2+}} + \underset{(s)}{S^{2-}}$, $K_{sp} = (s)(s)$

$$s = \sqrt{8 \times 10^{-37}} = 8.9 \times 10^{-19}\ \text{M}$$

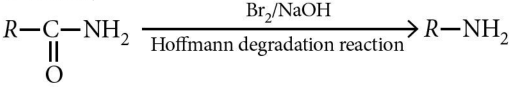
(iv) $\underset{(s)}{Ag_2S} \rightleftharpoons \underset{(2s)}{2Ag^+} + \underset{(s)}{S^{2-}}$

$$K_{sp} = (2s)^2 (s) = 4s^3$$

$$s = \left(\frac{6 \times 10^{-51}}{4}\right)^{1/3} = 1.14 \times 10^{-17}\ \text{M}$$

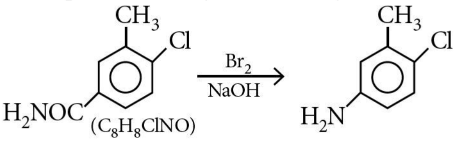
Hence, solubility is maximum for MnS.

3. **(b):** Problem can be solved by using back reaction. we know,

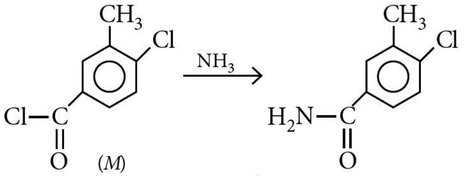


$$R-\underset{\underset{O}{\|}}{C}-NH_2 \xrightarrow[\text{Hoffmann degradation reaction}]{Br_2/NaOH} R-NH_2$$

So, as per the retrosynthesis analysis :



and



4. **(a):** We know, $\Delta x \times m\Delta v \geq \dfrac{h}{4\pi}$

$$\text{or} \quad \Delta v \geq \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 0.100 \times 10^{-10}}\ \text{m s}^{-1}$$

$\Delta v \geq 5.27 \times 10^{-24}\ \text{m s}^{-1}$

5. **(c)**

6. **(b):** C.F.S.E. = $(-0.4x + 0.6y)\Delta_o + zP$

where, x = number of electrons occupying t_{2g} orbital
y = number of electrons occupying e_g orbital
z = number of pairs of electrons

For low spin, d^6 complex electronic configuration

$= t_{2g}^6 e_g^0$ or $t_{2g}^{2,2,2} e_g^0$

$\therefore$ $x = 6, y = 0, z = 3$

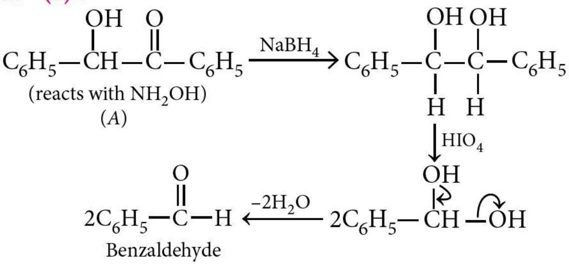
C.F.S.E. = $(-0.4 \times 6 + 0 \times 0.6)\Delta_o + 3P$

$$= \frac{-12}{5}\Delta_o + 3P$$

7. **(d):** In aqueous solution, $CuCr_2O_7$ dissociates as Cu^{2+} and $Cr_2O_7^{2-}$. Cu^{2+} ions are blue and $Cr_2O_7^{2-}$ ions are yellow, so solution as a whole appears green.

8. **(b):** In phospholipids, two of the three hydroxyl groups of glycerol are esterified with two carboxylic acids and third hydroxyl group is esterified with some derivative of phosphoric acid.

9. **(c) :**



10. **(a):** Be forms soluble $BeSO_4$ and insoluble $Be(OH)_2$. Both BeO and $Be(OH)_2$ are amphoteric in nature.

11. **(d):** The method of purification is used for the separation of an organic compound, from its aqueous solution by shaking it with a suitable solvent such as ether, chloroform or benzene. The solvent chosen should be immiscible with water and dissolve the organic compound to be separated.

12. **(c):** Mass of CO_2 formed = 0.198 g
Mass of H_2O formed = 0.1014 g
Mass of organic compound taken = 0.246 g

$$\%\ \text{of C} = \frac{12}{44} \times \frac{\text{Mass of } CO_2}{\text{Mass of compound}} \times 100$$

$$= \frac{12}{44} \times \frac{0.198}{0.246} \times 100 = 21.95\%$$

$$\%\ \text{of H} = \frac{2}{18} \times \frac{\text{Mass of } H_2O}{\text{Mass of compound}} \times 100$$

$$= \frac{2}{18} \times \frac{0.1014}{0.246} \times 100 = 4.58\%$$

EXAM ALERT 2023

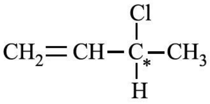
Exam	Date
JEE Main Session 2	6th, 8th, 10th, 11th and 12th April
WB JEE	30th April
NEET	7th May
CUET	21st to 31st May
MHT CET PCM	9th to 13th May
MHT CET PCB	15th to 20th May
BITSAT	Session - 1 : 22nd to 26th May
	Session - 2 : 18th to 22nd June
JEE Advanced	4th June

Element	Percentage	At. mass	Relative no. of atoms	Ratio
C	21.95	12	$\frac{21.95}{12} = 1.83$	$1.83 \cong 2.0$
H	4.58	1	$\frac{4.58}{1} = 4.58$	$4.58 \cong 5.0$

13. (a) : Lowering of E_a, raises the value of k.

14. (d): In disproportionation reaction, one element of a compound simultaneously gets reduced and oxidised. In ClO_4^-, oxidation number of Cl is +7 and it cannot increase it further. So, ClO_4^- will not get oxidised and thus, will not undergo disproportionation reaction.

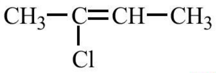
15. (a) : Acyclic stereoisomers having molecular formula C_4H_7Cl can be written as,



$CH_2{=}CH{-}\overset{Cl}{\underset{H}{C^*}}{-}CH_3$

(one asymmetric carbon)

Therefore, number of optical isomers = $2^n = 2^1 = 2$
Two geometrical isomers of each compound are possible for the following structures :
$ClHC{=}CH{-}CH_2{-}CH_3$, $ClH_2C{-}CH{=}CH{-}CH_3$
and



$CH_3{-}\underset{Cl}{C}{=}CH{-}CH_3$

16. (a) **17. (a)**

18. (c) : $\Delta H = H_2 - H_1 = (U_2 + P_2V_2) - (U_1 + P_1V_1)$
$= (U_2 - U_1) + (P_2V_2 - P_1V_1)$
$= 30 + 4 \times 5 - 2 \times 3 = 44$ L atm

19. (b): There are 4 chiral centres in glucose while 3 chiral centres in fructose.

20. (c)

21. (1.8) : $K_2HgI_4 \rightleftharpoons 2K^+ + HgI_4^{2-}$

$$\alpha = \frac{40}{100} = 0.4$$

In case of dissociation,

$$i = \frac{1+(n-1)\alpha}{1} \Rightarrow i = \frac{1+(3-1)0.4}{1} = 1.8$$

22. (8.85) : NH_4^+ and NH_3 are conjugate acid-base pair.
For conjugate acid-base pair, $pK_a + pK_b = 14$
$pK_b = 14 - 9.25 = 4.75$

$$pOH = pK_b + \log\frac{[\text{Conjugate acid}]}{[\text{Weak base}]}$$

$$= 4.75 + \log\frac{0.5}{0.2} = 4.75 + 0.40 = 5.15$$

pH = 14 – pOH = 14 – 5.15 = 8.85

23. (7): $NO_3^- \rightarrow N_2H_4$
To balance N atoms, multiplying NO_3^- by 2, we have

$$\overset{+5}{2NO_3^-} \longrightarrow \overset{-2}{N_2H_4}$$

Total O.N. $= 2 \times (+5)$ $= 2 \times (-2)$
$= +10$ $= -4$

To balance O.N., add 14 e^- to L.H.S.,
$2NO_3^- + 14e^- \rightarrow N_2H_4$
or $NO_3^- + 7e^- \rightarrow 1/2\ N_2H_4$
Therefore, number of electrons involved in the reduction of NO_3^- ions is 7.

24. (4)

25. (0.04) :

	PCl_5	$\rightleftharpoons$ PCl_3	+ Cl_2
Moles at eqm.	0.1 mol	0.2 mol	0.2 mol
Molar concs.	0.1/10	0.2/10	0.2/10

$$K = \frac{0.02 \times 0.02}{0.01} = 0.04$$

26. (76) : $2Hg \rightarrow Hg_2^{2+} + 2e^-$; $E° = -0.799V$ ...(i)
$Hg \rightarrow Hg^{2+} + 2e^-$; $E° = -0.855V$ ...(ii)
Subtracting eqn. (ii) from eqn.(i), we get
$Hg + Hg^{2+} \rightarrow Hg_2^{2+}$ ...(iii)

$$-nFE° = -nFE_1°-(-nFE_2°)$$
$$= -(nFE_1° - nFE_2°) = -nF(E_1° - E_2°)$$
$$= -2F(-0.799 + 0.855) = -2 \times 0.056\,F$$

Now, $-nFE° = -RT \ln K_{eq}$

$\therefore -RT \ln K_{eq} = -2{\times}0.056 \times 96500$

$$\Rightarrow \ln K_{eq} = \frac{2\times0.056\times96500}{8.314\times300} \Rightarrow K_{eq} = 76$$

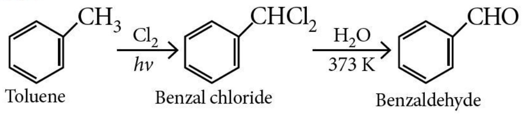
27. (3)

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

1.	(d)	**2.**	(c)	**3.**	(c)	**4.**	(d)	**5.**	(b)
6.	(a)	**7.**	(a)	**8.**	(b)	**9.**	(a)	**10.**	(b)
11.	(d)	**12.**	(a)	**13.**	(a)	**14.**	(c)	**15.**	(a)
16.	(b)	**17.**	(a)	**18.**	(a)	**19.**	(c)	**20.**	(a,c,d)
21.	(a,b,d)	**22.**	(b,c)	**23.**	(c,d)	**24.**	(3)	**25.**	(4)
26.	(2.8)	**27.**	(b)	**28.**	(c)	**29.**	(d)	**30.**	(d)

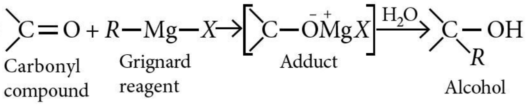
28. (2) :

(i)

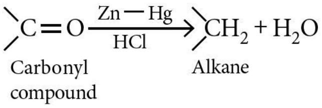

CH3
Cl2
hv
CHCl2
H2O
373 K
CHO
Toluene
Benzal chloride
Benzaldehyde

(ii) $\underset{\text{Nitriles}}{R-C\equiv N} \xrightarrow[Na(Hg)/C_2H_5OH]{H_2/Ni} \underset{\text{Amines}}{R-CH_2-NH_2}$

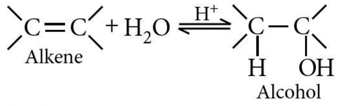
(iii)


C=O + R–Mg–X
Carbonyl compound
Grignard reagent
C–OMgX
Adduct
H2O
C–OH
R
Alcohol

(iv)


C=O
Zn–Hg
HCl
CH2 + H2O
Carbonyl compound
Alkane

(v)

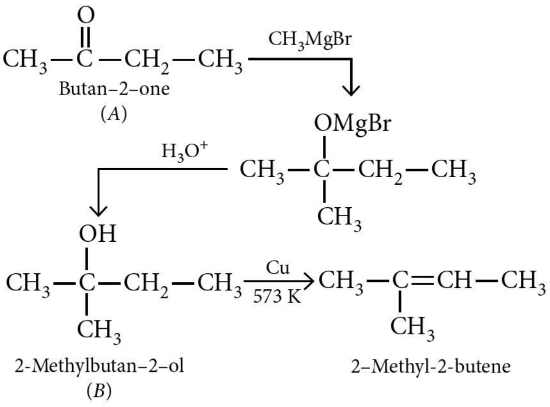

C=C + H2O
H+
Alkene
C–C
H OH
Alcohol

29. (42) : % Optical purity

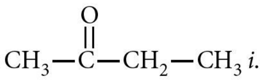
$$= \frac{\text{Observed rotation of mixture}}{\text{Rotation of pure enantionmer}} \times 100$$

$$= \frac{+12.6^\circ}{+30^\circ} \times 100 = 42$$

30. (66.67) :


O
CH3–C–CH2–CH3
Butan–2–one
(A)
CH3MgBr
OMgBr
CH3–C–CH2–CH3
CH3
H3O+
OH
CH3–C–CH2–CH3
CH3
Cu
573 K
CH3–C=CH–CH3
CH3
2-Methylbutan–2–ol
(B)
2–Methyl-2-butene

Compound *A* is



$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-CH_3$ *i.e.*, C_4H_8O.

Percentage of carbon in compound *A* is

$$\left(\frac{12\times 4}{48+16+8}\times 100\right) = 66.67\%$$

◆ ◆

PUBLIC NOTICE

JEE Main Session 2

Inviting Online Applications for Joint Entrance Examination (Main) – 2023 Session 2 - Reg.

In continuation of the Public Notice **dated: 15 December 2022**, the National Testing Agency is now inviting online Application Forms for **Joint Entrance Examination (Main) – 2023 Session 2**. The schedule for the same is given below :

Examination / Session	Dates of Examination	Submission of Application Forms Online	Last Date for Payment of Application Fee Online
JEE (Main) – 2023 Session 2	06, 08, 10, 11, and 12 April 2023 (Reserve dates – 13, 15 April 2023)	14 February to 12 March 2023 (up to 09:00 P.M.)	12 March 2023 (up to 11:50 P.M.)

The dates of Advance Intimation of Examination City, downloading of Admit Cards, and declaration of Result will be displayed on JEE (Main) portal in due course.

The candidates who have applied and successfully paid the Examination Fee for JEE (Main) – 2023 Session 1 and wish to appear for JEE (Main) – 2023 Session 2, are required to log in with their previous Application Number and Password as provided in Session 1. They may only choose the **Paper, Medium of the Examination, State code of Eligibility and cities for Session 2 and pay the Examination Fees**.

The candidates are not allowed to fill more than one Application Form. Any candidate with more than one Application Number will be treated as UFM (Unfair Means), even if found at a later stage, and strict action will be taken against that Candidate.

The candidates who have already registered for Session 1 are not required to register again.

Those candidates who have not applied earlier, need to apply afresh as per the schedule given. For details, candidates may refer to the table below.

1.	Existing candidates i.e. candidates registered for Session 1 and Paid Fee be considered for Session 2	**Already registered candidates in Session 1 i.e. existing candidates for Session 2 :** Candidates are allowed to opt for the following: i. *Course (Paper)* ii. *Medium of Question Paper* iii. *State code of Eligibility* iv. *Examination Cities* v. *Fee Payment*
2.	For new candidates, the process for registration and application form filling in Session 2 will remain the same as followed in Session 1.	**For new candidates in Session 2 i.e. not registered including Fee not paid for Session 1 :** Process for registration and Application will remain the same as followed for Session 1.

The Candidates are advised to keep visiting the official websites of NTA **(www.nta.ac.in)** and **(https://jeemain.nta.nic.in/)** for the latest updates. For further clarification related to JEE (Main) – 2023, the candidates can also contact **011- 40759000/011-69227700** or email at **jeemain@nta.ac.in**.

PRACTICE PAPER

NEET 2023

Exam on
7th May 2023

SECTION - A

1. The frequency factor of a reaction can be determined from the intercept of which of the following graphs?

(a) $\ln k \ vs \ \frac{1}{T}$ (b) $\frac{T}{\ln k} \ vs \ \frac{1}{T}$

(c) $\ln k \ vs \ T$ (d) $\frac{\ln k}{T} \ vs \ T$

2. Why do calcium ions make water hard but sodium ions do not?

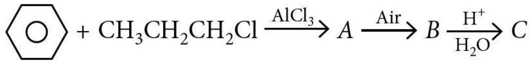
(a) Calcium forms insoluble compounds with stearate ions present in soap.

(b) Sodium forms insoluble compounds with stearate ions present in soap.

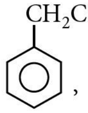
(c) Calcium forms soluble compounds with stearate ions present in soap.

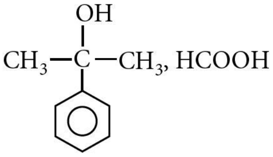
(d) Both calcium and sodium form insoluble compounds with stearate ions present in soap.

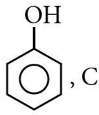
3.

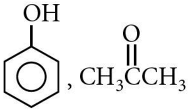


(C) is a mixture of

(a)

, HCOOH

(b)


(c)

, CH_3CH_2CHO

(d)


4. In which of the following processes, iron is not oxidised?

(a) Formation of $Fe(CO)_5$ from Fe.

(b) Decolourisation of blue $CuSO_4$ solution by iron.

(c) Rusting of iron sheets.

(d) Liberation of H_2 from steam by iron at high temperature.

5. 20 mL of acetic acid reacts with 20 mL of ethyl alcohol to form ethyl acetate. The density of acid and alcohol are 1 g/mL and 0.7 g/mL respectively. The limiting reagent in this reaction is

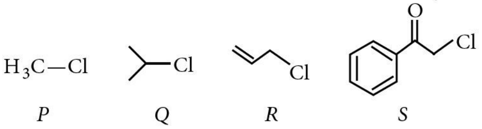
(a) acetic acid

(b) ethyl alcohol

(c) both acetic acid and ethyl alcohol are present in required quantity

(d) ester.

6. KI in acetone, undergoes S_N2 reaction with each of P, Q, R and S. The rates of the reaction vary as

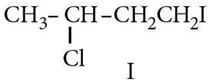


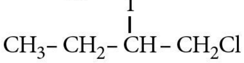
(a) $P > Q > R > S$ (b) $S > P > R > Q$

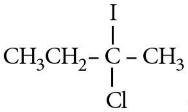
(c) $P > R > Q > S$ (d) $R > P > S > Q$

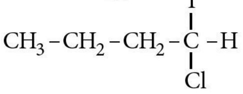
7. Predict the product Q obtained in the following reaction of 1-butyne.

$$CH_3CH_2-C\equiv CH + HCl \longrightarrow P \xrightarrow{HI} Q$$

(a)

$CH_3-\underset{Cl}{CH}-CH_2CH_2I$

(b)

$CH_3-CH_2-\overset{I}{CH}-CH_2Cl$

(c)

$CH_3CH_2-\overset{I}{\underset{Cl}{C}}-CH_3$

(d)

$CH_3-CH_2-CH_2-\overset{I}{\underset{Cl}{C}}-H$

8. One mole of magnesium nitride on reaction with excess of water gives
(a) one mole of ammonia
(b) one mole of nitric acid
(c) two moles of ammonia
(d) two moles of nitric acid.

9. Which of the following pairs is not correctly matched?
(a) Hund's rule : In orbitals of equivalent energy, electron spins remain unpaired if possible.
(b) Pauli's exclusion principle : No two electrons can have all the four quantum numbers identical.
(c) Zeeman effect : The effect of magnetic field on the atomic spectra.
(d) Uncertainty principle : It is impossible to determine the position of an electron.

10. Match the reagent from Column I which on reaction with $CH_3-CH=CH_2$ gives product given in Column II and select the correct option.

Column I	**Column II**
(i) $O_3/Zn + H_2O$	(A) Acetic acid and CO_2
(ii) $KMnO_4/H^+$	(B) Propan-1-ol
(iii) $KMnO_4/OH^-$	(C) Propan-2-ol
(iv) H_2O/H^+	(D) Acetaldehyde and formaldehyde
(v) $B_2H_6/NaOH$	(E) Propane-1,2-diol and H_2O_2

(a) (i)-(D), (ii)-(A), (iii)-(E), (iv)-(C), (v)-(B)
(b) (i)-(B), (ii)-(C), (iii)-(D), (iv)-(E), (v)-(A)
(c) (i)-(C), (ii)-(D), (iii)-(A), (iv)-(B), (v)-(E)
(d) (i)-(D), (ii)-(E), (iii)-(C), (iv)-(A), (v)-(B)

11. Ge(II) compounds are powerful reducing agents whereas Pb(IV) compounds are strong oxidants. This can be due to
(a) Pb is more electropositive than Ge
(b) ionization potential of lead is less than that of Ge
(c) ionic radii of Pb^{2+} and Pb^{4+} are larger than those of Ge^{2+} and Ge^{4+}
(d) more pronounced inert pair effect in lead than in Ge.

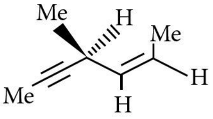
12. Assertion : Excessive use of chlorinated synthetic pesticides causes soil and water pollution.
Reason : Such pesticides are non-biodegradable.
(a) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
(c) Both Assertion and Reason are not correct.
(d) Assertion is not correct but Reason is correct.

13. Assertion : A reaction which is spontaneous and accompanied by decrease of randomness must be exothermic.
Reason : All exothermic reactions are accompanied by decrease of randomness.
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

14. Which of the following are anionic detergents?
I. Sodium salts of sulphonated long chain alcohol.
II. Ester of stearic acid and polyethylene glycol.
III. Quarternary ammonium salt of amine with acetate ion.
IV. Sodium salts of sulphonated long chain hydrocarbons.
(a) II and III only
(b) I, II and III only
(c) I and IV only
(d) I, II, III and IV

15. Which one of the following pairs of molecules will have permanent dipole moments for both members?
(a) SiF_4 and NO_2
(b) NO_2 and CO_2
(c) NO_2 and O_3
(d) SiF_4 and CO_2

16.



Hydrogenation of the above compound in the presence of poisoned palladium catalyst gives
(a) an optically active compound
(b) an optically inactive compound
(c) a racemic mixture
(d) a diastereomeric mixture.

17. Assertion : Number of radial and angular nodes for $3p$-orbital are 1 and 1 respectively.
Reason : Number of radial and angular nodes depends only on principal quantum number.
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

18. A compound with nitro group was reduced by Sn/HCl, followed by treatment with $NaNO_2$/HCl and followed by phenol. The chromophore group in the final compound is

(a) NO_2 group (b) NH_2 group
(c) azo group (d) OH group.

19. Select the correct information about actinoids.

(a) All are synthetic elements.
(b) They include element with atomic number 104.
(c) They have only short lived isotopes.
(d) They have variable valency.

20. The yield of the products in the reaction, $A_{2(g)} + 2B_{(g)} \rightleftharpoons C_{(g)} + Q$ kJ would be higher at

(a) high temperature and high pressure
(b) high temperature and low pressure
(c) low temperature and high pressure
(d) low temperature and low pressure.

21. Match list I with list II and select the correct answer using the codes given below:

	List I (Polymers)		**List II (Monomers)**
1.	Buna-N	A.	Phthalic acid and ethylene glycol
2.	Nylon 6,6	B.	Terephthalic acid and ethylene glycol
3.	Dacron	C.	Hexamethylene diamine and adipic acid
4.	Glyptal plastic	D.	Isobutylene and isoprene
		E.	Acrylonitrile and butadiene

(a) 1-B, 2-A, 3-D, 4-E (b) 1-C, 2-D, 3-A, 4-B
(c) 1-D, 2-C, 3-B, 4-A (d) 1-E, 2-C, 3-B, 4-A

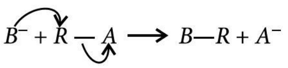
22. Which of the following is not oxidised by O_3?

(a) KI (b) $FeSO_4$
(c) $KMnO_4$ (d) K_2MnO_4

23. Which of the following statements is incorrect?

(a) $B(OH)_3$ partially reacts with water to form H_3O^+ and $[B(OH)_4]^-$, and behaves like a weak acid.
(b) $B(OH)_3$ behaves like a strong monobasic acid in the presence of sugars, and this acid can be titrated against NaOH solution using phenolphthalein as an indicator.
(c) $B(OH)_3$ does not donate a proton and hence, does not form any salt with NaOH.
(d) $B(OH)_3$ reacts with NaOH, forming $Na[B(OH)_4]$.

24. To which of the following four types, does this reaction belong?



(a) Unimolecular electrophilic substitution
(b) Bimolecular electrophilic substitution
(c) Unimolecular nucleophilic substitution
(d) Bimolecular nucleophilic substitution

25. Pick out the wrong combination.

(a) Co^{2+} - Vitamin B_{12}
(b) P - Insulin
(c) Mg^{2+} - Photosynthesis
(d) Fe^{2+} - Haemoglobin

26. Give below are two statements:

Statement-I : For hydrogen like species, energy of an electron in a particular orbit increases with increase in the value of Z.

Statement-II : Electronegativity decreases across a period.

(a) Both statement-I and statement-II are correct.
(b) Both statement-I and statement-II are incorrect.
(c) Statement-I is correct but statement-II is incorrect.
(d) Statement-I is incorrect but statement-II is correct.

27. Match the items in Column I and Column II.

	Column I		**Column II**
A.	Melting of snow by salt	(i)	Isotonic solution
B.	$\Delta H_{mix} = 0$	(ii)	Positive deviation from Raoult's law
C.	$\pi_1 = \pi_2$	(iii)	Negative deviation from Raoult's law
D.	$p_A > x_A p_A^\circ$, $p_B > x_B p_B^\circ$	(iv)	Depression in freezing point
E.	Maximum boiling azeotropes	(v)	Ideal solution

(a) $A \to (iv),\ B \to (ii),\ C \to (iii),\ D \to (v),\ E \to (i)$
(b) $A \to (iv),\ B \to (iii),\ C \to (i),\ D \to (v),\ E \to (ii)$
(c) $A \to (iv),\ B \to (v),\ C \to (i),\ D \to (ii),\ E \to (iii)$
(d) $A \to (v),\ B \to (i),\ C \to (ii),\ D \to (iii),\ E \to (iv)$

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28. An example of a neutral salt is
(a) ammonium hydroxide and ammonium chloride
(b) acetic acid and sodium acetate
(c) acetic acid and ammonium hydroxide
(d) citric acid and sodium citrate.

29. Which represents the correct Nernst equation for redox reaction $O + ne^- \rightleftharpoons R$?

(a) $E = E^\circ - \frac{RT}{nF}\ln\frac{[O]}{[R]}$ (b) $\frac{[O]}{[R]} = e^{\frac{nF}{RT}(E-E^\circ)}$

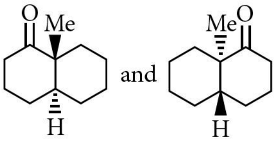
(c) $\frac{[O]}{[R]} = e^{\frac{-nF}{RT}(E-E^\circ)}$ (d) $\frac{[O]}{[R]} = e^{\frac{RT}{nF}(E-E^\circ)}$

30. Which of the following factors may be regarded as the main cause of lanthanide contraction?
(a) Poor shielding of one of the 4*f*-electrons by another in the subshell.
(b) Effective shielding of one of the 4*f*-electrons by another in the subshell.
(c) Poorer shielding of 5*d*-electrons by 4*f*-electrons.
(d) Greater shielding of 5*d*-electrons by 4*f*-electrons.

31. Kohlrausch's law is applicable to a dilute solution of
(a) potassium chloride in hexane
(b) acetic acid in benzene
(c) hydrochloric acid in water
(d) benzoic acid in benzene.

32. In a periodic table, the basic character of oxides
(a) increases from left to right and decreases from top to bottom
(b) decreases from right to left and increases from top to bottom
(c) decreases from left to right and increases from top to bottom
(d) decreases from left to right and increases from bottom to top.

33. The two compounds given below are
(a) enantiomers
(b) identical
(c) diastereomers
(d) regioisomers.



34. For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter, ΔU and w correspond to
(a) $\Delta U < 0, w = 0$ (b) $\Delta U < 0, w < 0$
(c) $\Delta U > 0, w = 0$ (d) $\Delta U > 0, w > 0$

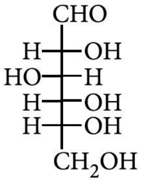
35. The oxidation state of the most electronegative element in the products of the reaction between BaO_2 and H_2SO_4 are
(a) 0 and –1 (b) –1 and –2
(c) –2 and 0 (d) –2 and +1

SECTION - B

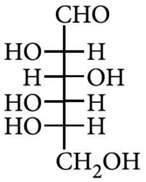
Attempt any 10 questions out of 15.

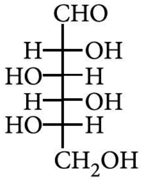
36. Of the following molecules, which have shape similar to CO_2?
(a) $HgCl_2$ (b) $SnCl_2$ (c) SO_2 (d) NO_2

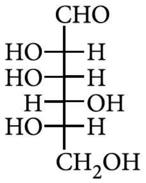
37. The structure of *D*-(+)-glucose is

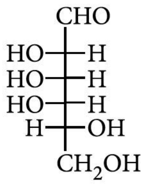


The structure of *L*-(–)-glucose is

(a)


(b)


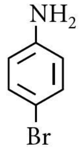
(c)


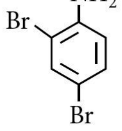
(d)


38. H_5IO_6 is a
(a) strong reducing agent (b) strong base
(c) strong oxidizing agent (d) weak base.

39. In Carius method of estimation of halogens, 0.172 g of an organic compound showed presence of 0.08 g of bromine. Which of these is the correct structure of the compound?

(a) H_3C-CH_2-Br

(b)


(c)


(d) H_3C-Br

40. The two functional groups present in a typical carbohydrate are
(a) –OH and –COOH (b) –CHO and –COOH
(c) $\rangle C{=}O$ and –OH (d) –OH and –CN

41. The statement that is not correct is
(a) compressibility factor measures the deviation of real gas from ideal behaviour
(b) van der Waals constant 'a' measures extent of intermolecular attractive forces for real gases
(c) critical temperature is the lowest temperature at which liquefaction of a gas first occurs
(d) Boyle point depends on the nature of real gas.

42. In a ferromagnetic material,
(a) all the magnetic moment vectors are aligned in one direction
(b) half of the magnetic moment vectors point in one direction and rest in the opposite direction
(c) all the magnetic moment vectors are randomly oriented
(d) the magnetic moment is very small.

43. Which of the following can act as a nucleophile?
(a) BF_3 (b) $AlCl_3$
(c) H_3O^+ (d) C_2H_5MgBr

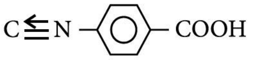
44. The root mean square speed (*rms*) of the molecules of diatomic gas is u. When the temperature is doubled, the molecules dissociate into two atoms. The new *rms* speed of the atom is
(a) $\sqrt{2}u$ (b) u (c) $2u$ (d) $4u$

45. The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298 K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fractions of components A and B in vapour phase, respectively are
(a) 450 mmHg, 0.5, 0.5 (b) 450 mmHg, 0.4, 0.6
(c) 500 mmHg, 0.5, 0.5 (d) 500 mmHg, 0.4, 0.6

46. Which of the following statements is correct?
(a) sp^3 hybrid orbitals have equal s and p character.
(b) The bond angle decreases with the decrease of s character of hybridized orbital.
(c) Resonance decreases the stability of a molecule.
(d) Resonance is due to delocalization of sigma electrons.

47. Which of the following reagents could be used to distinguish aniline from methanamine?
(i) Bromine water
(ii) $CHCl_3$ and aqueous KOH
(iii) Dilute HCl
(iv) Nitration mixture under heated condition
(a) (i) only (b) (i) and (ii)
(c) (i) and (iii) (d) (i) and (iv)

48. The correct IUPAC name of


is

(a) 4-Isocyanobenzoic acid
(b) 4-Carbylaminebenzoic acid
(c) 4-Isonitrilebenzoic acid
(d) 2-Isocyanobenzoic acid

49. Match the lists I and II and pick the correct matching from the codes given below :

List I	List II
(A) $[Ag(CN)_2]^-$	1. Square planar and 1.73 B.M.
(B) $[Cu(CN)_4]^{3-}$	2. Linear and zero
(C) $[Cu(CN)_6]^{4-}$	3. Octahedral and zero
(D) $[Cu(NH_3)_4]^{2+}$	4. Tetrahedral and zero
(E) $[Fe(CN)_6]^{4-}$	5. Octahedral and 1.73 B.M.

(a) A – 2, B – 4, C – 5, D – 1, E – 3
(b) A – 5, B – 4, C – 1, D – 3, E – 2
(c) A – 1, B – 3, C – 4, D – 2, E – 5
(d) A – 4, B – 5, C – 2, D – 1, E – 3

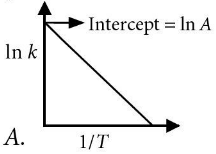
50. For one mole of an ideal gas, the slope of V *vs* T curve at constant pressure of 2 atm is X lit mol^{-1} K^{-1}. The value of the ideal universal gas constant 'R' in terms of X is
(a) X lit atm mol^{-1} K^{-1}
(b) $X/2$ lit atm mol^{-1} K^{-1}
(c) $2X$ lit atm mol^{-1} K^{-1}
(d) $2X$ atm lit^{-1} mol^{-1} K^{-1}

SOLUTIONS

1. (a) : According to Arrhenius equation,

$$k = Ae^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$



Hence, if ln k is plotted against $1/T$, intercept of the line will be ln A.

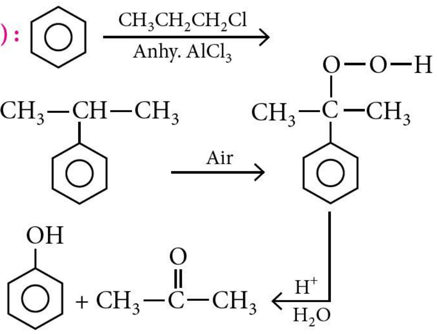
2. (a) : Calcium forms insoluble compound with stearate ions present in the soap causing hardness of water.

$$Ca^{2+}_{(aq)} + 2C_{17}H_{35}COO^-_{(aq)} \rightarrow \underset{\substack{\text{Calcium stearate} \\ \text{(Insoluble precipitate)}}}{(C_{17}H_{35}COO)_2Ca}$$

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1.	(d)	**2.**	(b)	**3.**	(c)	**4.**	(a)	**5.**	(c)
6.	(b)	**7.**	(a)	**8.**	(b)	**9.**	(d)	**10.**	(a)
11.	(b)	**12.**	(d)	**13.**	(a)	**14.**	(d)	**15.**	(a)
16.	(d)	**17.**	(c)	**18.**	(a)	**19.**	(c)	**20.**	(a, b)
21.	(a, c, d)	**22.**	(a,b)	**23.**	(a,c)	**24.**	(20)	**25.**	(2.8)
26.	(6)	**27.**	(a)	**28.**	(a)	**29.**	(c)	**30.**	(d)

3. (d) :



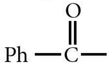
4. (a) : Oxidation number of Fe in $Fe(CO)_5$ is zero.

5. (b) : Mass of 20 mL of acetic acid = 20 × 1 = 20 g
Mass of 20 mL of ethyl alcohol = 20 × 0.7 = 14 g

$$\underset{60\text{ g}}{CH_3COOH} + \underset{46\text{ g}}{C_2H_5OH} \longrightarrow CH_3COOC_2H_5 + H_2O$$

60 g of acetic acid reacts with 46 g of ethyl alcohol. So, 20 g of acetic acid reacts with 15.3 g of ethyl alcohol. Therefore, ethyl alcohol is the limiting reagent.

6. (b) : The bulky groups cause steric hindrance in the formation of transition state. Therefore, (*Q*) and (*R*) are less reactive than (*P*).
(*R*) is more reactive than (*Q*) as in (*Q*), two $-CH_3$ groups are directly attached to carbon of C—Cl bond. In compound (*S*), the transition state is highly stabilized by



$Ph-\overset{\overset{\displaystyle O}{\|}}{C}-$

group, so it has highest rate of reaction towards S_N2.
Hence, the order of rate of reaction is $S > P > R > Q$.

7. (c)

8. (c) : $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$

9. (d) : According to uncertainty principle, it is impossible to measure simultaneously, the position and momentum of an electron with absolute accuracy.

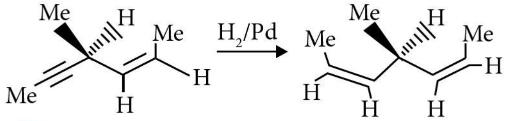
10. (a) : (i) - (D), (ii) - (A), (iii) - (E), (iv) - (C), (v) - (B)

11. (d) : Ge^{4+} is more stable than Ge^{2+} as a result of which Ge^{2+} has a tendency to be oxidised to Ge^{4+} so, Ge^{2+} compounds act as powerful reducing agents. But Pb^{2+} is more stable than Pb^{4+} because of pronounced inert pair effect as a result of which Pb^{4+} has a tendency to get reduced to Pb^{2+} so, Pb^{4+} compounds act as strong oxidising agents.

12. (a) **13. (c)** **14. (c)**

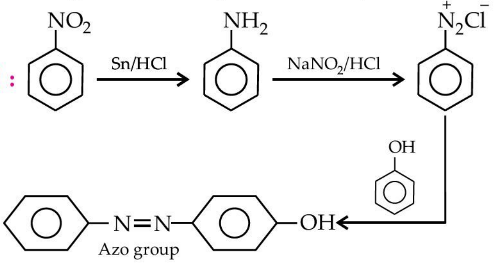
15. (c) : NO_2 and O_3 both have unsymmetrical structures, so they have permanent dipole moment.

16. (b) : Addition on a triple bond occurs by *syn*-addition of hydrogen. The configuration of double bond already present is *cis*. The compound formed will have a plane of symmetry and thus it will be optically inactive.



17. (c) : For 3*p*-orbital, number of radial nodes
$= n - l - 1 = 3 - 1 - 1 = 3 - 2 = 1$
Number of angular nodes (*l*) = 1
Number of radial nodes depends on both *n* and *l* while number of angular nodes depends on *l* only.

18. (c) :



19. (d) : Many actinoids exist in nature and some have long lived isotopes. Actinoids include elements from atomic number 90 to 103. They have variable valency.

20. (c) : $\underbrace{\underset{1\text{ mole}}{A_{2(g)}} + \underset{2\text{ moles}}{2B_{(g)}}}_{3\text{ moles}} \rightleftharpoons \underset{1\text{ mole}}{C_{(g)}} + Q\text{ kJ}$

According to Le Chatelier's principle, on increasing pressure the equilibrium will shift in that direction in which pressure decreases *i.e.*, decrease in the number of moles. Thus, high pressure and low temperature would favour the formation of product '*C*'.

21. (d)

22. (c) : In $KMnO_4$, the oxidation state of Mn is +7 which is the highest possible oxidation state of Mn and thus no further oxidation is possible.

23. (c) : Boric acid being acidic in nature forms salt with NaOH known as metaborates.

$$B(OH)_3 + NaOH \longrightarrow B(OH)_4^- + Na^+ \longrightarrow \underset{\text{Sodium metaborate}}{Na^+BO_2^-} + 2H_2O$$

24. (d) : The given reaction is single step so, bimolecular nucleophilic substitution (S_N2) reaction.

25. (b) : Sulphur (S) is present in insulin, not phosphorus.

26. (c) : For hydrogen like species, energy of an electron in n^{th} orbit is given by

$$E_n = -\frac{2\pi^2 mZ^2e^4k^2}{n^2h^2} \quad i.e., E_n \propto Z^2.$$

Electronegativity increases across a period with decrease in the size of atom.

27. (c)

28. (c) : $\underset{\text{Weak acid, } K_a}{CH_3COOH} + \underset{\text{Weak base, } K_b}{NH_4OH} \longrightarrow \underset{\text{(Neutral salt)}}{CH_3COONH_4} + H_2O$

Here, $K_a = K_b$ *i.e.*, solution will be neutral in nature.

29. (b) : $O + ne^- \rightleftharpoons R$

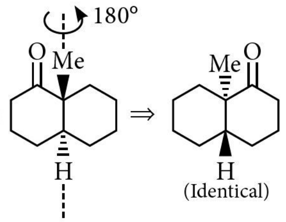
$$E = E^\circ - \frac{RT}{nF}\ln\frac{[R]}{[O]} \Rightarrow -\ln\frac{[R]}{[O]} = \frac{nF}{RT}(E - E^\circ)$$

$$\Rightarrow \ln\frac{[O]}{[R]} = \frac{nF}{RT}(E - E^\circ), \text{ so, } \frac{[O]}{[R]} = e^{\frac{nF}{RT}(E - E^\circ)}$$

30. (a) **31. (c)**

32. (c) : As the electronegativity of the elements increases, acidic character of oxides increases. So, in a group, basic nature increases on moving down and decreases on moving left to right across a period.

33. (b) :



34. (a) : Bomb calorimeter, commonly used to find the heat of combustion of organic substances, contains a sealed combustion chamber, known as a bomb.

The reaction in a bomb calorimeter takes place at a constant volume so, $w = 0$ and $\Delta U = q$.

Hence, $\Delta U < 0$, $w = 0$.

35. (b) : $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

The most electronegative element in the product is oxygen.

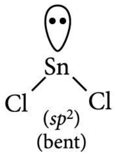
Oxidation number of oxygen in $BaSO_4$:

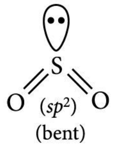
$(+2) + (+6) + 4(x) = 0 \Rightarrow x = -2$

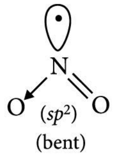
Oxidation number of oxygen in H_2O_2 :

$2(+1) + 2(x) = 0 \Rightarrow x = -1$

36. (a) : Cl — Hg — Cl
(*sp*)
(linear)







37. (a)

38. (c) : In H_5IO_6, iodine (I) is present in +7 oxidation state, which is maximum. Therefore, it acts as a strong oxidizing agent.

39. (b) : Since, 0.172 g organic compound gives 0.08 g bromine. Hence, 172 g organic compound will give 80 g bromine, which matches with option (b).

40. (c)

41. (c) : Critical temperature is the temperature above which a gas cannnot be liquefied irrespective of the pressure applied.

42. (a)

43. (d) : Grignard reagent, C_2H_5MgBr can act both as electrophile and as nucleophile.

44. (c)

45. (d) : According to Raoult's law: $p = p_A^\circ x_A + p_B^\circ x_B$

If $x_B = 0.5$ then $x_A = 1 - 0.5 = 0.5$

$p_A^\circ = 400$ mmHg, $p_B^\circ = 600$ mmHg

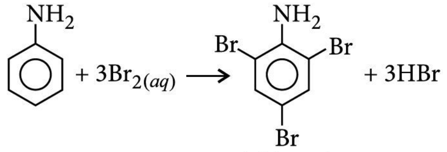
$p = 0.5\,(400) + 0.5\,(600) = 200 + 300 = 500$ mmHg

Mole fraction in vapour phase can be given as

$$y_A = \frac{x_A p_A^\circ}{p} = \frac{0.5 \times 400}{500} = 0.4; \; y_B = \frac{x_B p_B^\circ}{p} = \frac{0.5 \times 600}{500} = 0.6$$

46. (b)

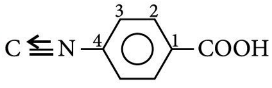
47. (d) : When bromine water is added to aniline at room temperature, decolourisation of the bromine water occurs and a white ppt. of 2,4,6–tribromoaniline is obtained.



(white ppt.)

Methanamine does not react with bromine water. Diazotisation of aniline will give benzene diazonium chloride which will further form an orange dye with 2-naphthol and dil. NaOH whereas methanamine will liberate N_2 on reaction with HNO_2.

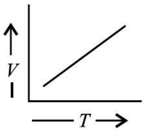
48. (a) :



4-Isocyanobenzoic acid

49. (a)

50. (c) : We can take T to be the independent variable and V to be the dependent variable. Now, for one mole of an ideal gas, $PV = RT$



$$\Rightarrow \frac{V}{T} = \frac{R}{P} \Rightarrow \text{Slope} = \frac{R}{P} = X \text{ lit mol}^{-1}\text{ K}^{-1}$$

$\Rightarrow R = P \times X$ lit $\text{mol}^{-1}\text{ K}^{-1}$

$R = 2 \text{ atm} \times X$ lit $\text{mol}^{-1}\text{ K}^{-1}$ ($\because P = 2$ atm)

$\Rightarrow R = 2X$ lit atm $\text{mol}^{-1}\text{ K}^{-1}$

◆

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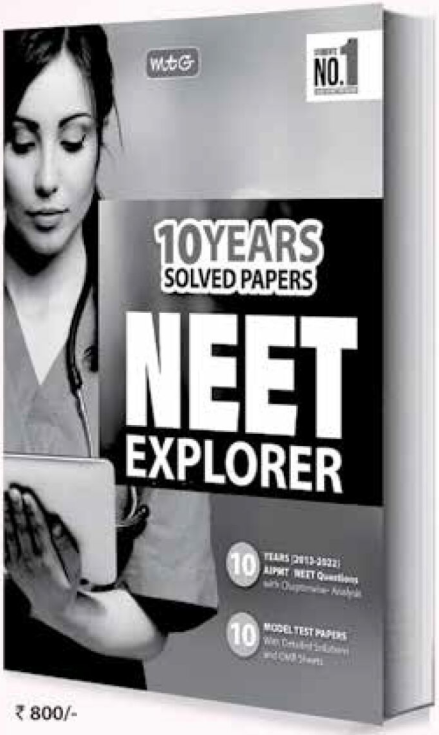
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CHAPTERWISE PRACTICE PAPER 2023

CUET (UG)

Exam on
21^{st} to 31^{st}
May 2023

SERIES - VII Alcohols, Phenols and Ethers | Biomolecules

Section II of CUET (UG) is domain specific. In this section of Chemistry 40 questions to be attempted out of 50.

Time Allowed : 45 Minutes **Maximum Marks** : 200

Section A

(All questions are compulsory.)

1. The general formula, which represents the homologous series of alcohol is

(a) $C_nH_{2n}O$ (b) $C_nH_{2n+1}O$

(c) $C_nH_{2n}O_2$ (d) $C_nH_{2n+2}O$

2. The letter '*D*' in carbohydrates signifies

(a) dextrorotatory (b) configuration

(c) diamagnetic nature (d) mode of synthesis.

3. In vinyl alcohol, —OH group is attached to

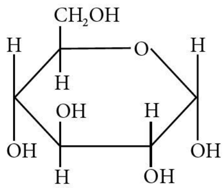
(a) *sp*-hybridised carbon atom

(b) sp^2-hybridised carbon atom

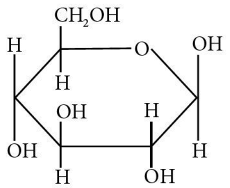
(c) sp^3-hybridised carbon atom

(d) sp^3d-hybridised carbon atom.

4. Study the structures of α-*D*-(+)-glucopyranose (I) and β-*D*-(+)-glucopyranose (II) and mark the correct statement.



I



II

(a) Structures I and II are enantiomers.

(b) Structures I and II are anomers.

(c) The two structures I and II differ in the configuration of C_1 and C_4.

(d) Both the structures I and II give 2, 4-DNP test.

5. Among the naturally occurring carbohydrates, furanose ring is found in the

(a) glucose unit of cane sugar

(b) glucose unit of cellulose

(c) fructose unit of cane sugar

(d) galactose unit of lactose.

6. Which of the following alcohols is prepared by acid catalysed hydration of ethene?

(a) Butan-1-ol (b) Propan-1-ol

(c) Ethanol (d) Methanol

7. Which of the following statements is not true?

(a) Glucose and fructose both are monosaccharides.

(b) The natural glucose and fructose are *D*-forms.

(c) The solution having equal amounts of *D*-(+)-glucose and *D*-(–)-fructose is termed as invert sugar.

(d) Aldohexoses exist in 2^6 optical forms.

8. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	Williamson's synthesis	(i)	$C_6H_5OH + CH_3COCl$ in presence of pyridine
(B)	*ROR*′	(ii)	$C_2H_5ONa + C_2H_5Br$
(C)	*p*-Nitrophenol	(iii)	Unsymmetrical ether
(D)	Acetylation	(iv)	Intermolecular hydrogen bonding

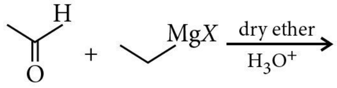
(a) (A) → (i), (B) → (iii), (C) → (ii), (D) → (iv)

(b) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)

(c) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)

(d) (A) → (iv), (B) → (i), (C) → (ii), (D) → (iii)

9. Isobutyl alcohol cannot be obtained by the reactions

1.


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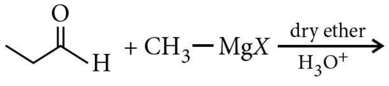
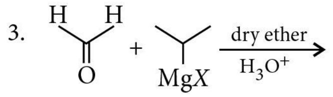
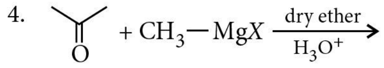


3. 

4. 

(a) 1, 2, 3 (b) 1, 2, 4 (c) 1, 3, 4 (d) 3, 4

10. Cellulose present in plants acts as a food for cattles but not for human beings because

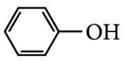
(a) human body does not contain the enzyme cellulase, hence cellulose cannot be broken into *D*-glucose

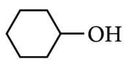
(b) human saliva cannot break down plant cellulose in small pieces

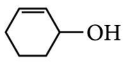
(c) bile juice present in cattles helps them to digest cellulose

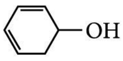
(d) human beings have smaller stomach than cattles.

11. Dehydration of the following in increasing order is

(I) 

(II) 

(III) 

(IV) 

(a) I < II < III < IV (b) II < III < IV < I

(c) I < III < IV < II (d) None of these.

12. Match the enzymatic reactions given in column-I and enzymes in column-II and select the correct option.

Column-I		Column-II	
(A)	Maltose $\rightarrow$ Glucose	(i)	Zymase
(B)	Sucrose $\rightarrow$ Glucose + Fructose	(ii)	Pepsin
(C)	Glucose $\rightarrow$ Ethyl alcohol + CO_2	(iii)	Maltase
(D)	Starch $\rightarrow$ Maltose	(iv)	Invertase
(E)	Proteins $\rightarrow$ Amino acids	(v)	Diastase

(a) (A) - (ii), (B) - (iv), (C) - (v), (D) - (iii),(E) - (i)

(b) (A) - (iii), (B) - (iv), (C) - (i), (D) - (v),(E) - (ii)

(c) (A) - (v), (B) - (iv), (C) - (ii), (D) - (i),(E) - (iii)

(d) (A) - (v), (B) - (iii), (C) - (iv), (D) - (ii),(E) - (i)

13. Select the correct statements from the following :

(A) Glyceraldehyde contains one asymmetric carbon atom and exists in two enantiomeric forms.

(B) The α form of glucose is obtained by the crystallisation from hot and saturated aqueous solution at 371 K.

(C) The hydrolysis of glucose gives an equimolar mixture of *D*-(+)-glucose and *D*-(–)-fructose.

(D) Maltose is composed of two α-*D*-glucose units in which C_1 of one glucose is linked to C_4 of another glucose unit.

(E) Lactose is a non-reducing sugar.

(a) (A), (B) and (C) only

(b) (A), (C) and (D) only

(c) (B) and (E) only

(d) (B), (C) and (D) only

14. Amino acids generally exist in the form of Zwitter ions. This means, they contain

(a) basic $—NH_2$ group and acidic —COOH group

(b) basic $—\overset{+}{N}H_3$ group and acidic $—COO^-$ group

(c) basic $—NH_2$ group and acidic $—H^+$ group

(d) basic $—COO^-$ group and acidic $—\overset{+}{N}H_3$ group.

15. **Statement-I :** Glucose is correctly named as *D*-(+)-glucose.

Statement-II : '*D*' before the name of glucose represents its dextrorotatory nature.

(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.

(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.

(c) Statement-I is correct but statement-II is wrong.

(d) Statement-I is wrong but statement-II is correct.

Section B

(Attempt any 25 questions.)

16. Select the correct statements from the following :

(A) The IUPAC name of $C_6H_5O(CH_2)_6—CH_3$ is 1-phenoxyheptane.

(B) Carboxylic acids are reduced to primary alcohols in excellent yields by lithium aluminium hydride.

(C) The solubility of alcohols and phenols decreases with an increase in the size of hydrophobic groups.

(D) *m*-Nitrophenol is less acidic than *o*-Nitrophenol.

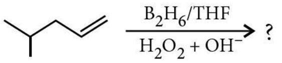
Recipe for Success

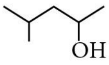
> " You don't have to be great to start, but you have to start to be great "
>
> *Zig Ziglar, An American Author*

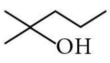
(E) The reaction of phenol with conc. HNO_3 produces picric acid.

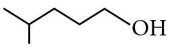
(a) (A), (B) and (C) only
(b) (B), (C) and (E) only
(c) (A), (C) and (E) only
(d) All of the given statements.

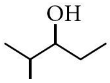
17. Product of the following reaction is



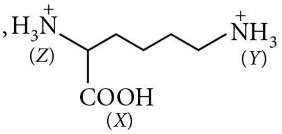
(a)


(b)


(c)


(d)


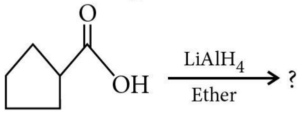
18. Consider the compound,

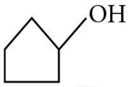


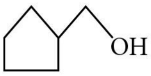
and arrange X, Y, Z in the correct order of acidic strength.

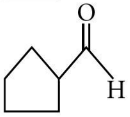
(a) $X > Z > Y$ (b) $Z < X < Y$
(c) $X > Y > Z$ (d) $Z > X > Y$

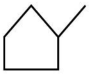
19. Product of the following reaction is



(a)


(b)


(c)


(d)


20. 'Convulsions' disease is caused by the deficiency of

(a) Vitamin K (b) Vitamin B_6
(c) Vitamin D (d) Vitamin A.

21. Denaturation of proteins leads to loss of its biological activity by

(a) formation of amino acids
(b) loss of primary structure
(c) loss of both primary and secondary structures
(d) loss of both secondary and tertiary structures.

22. The decreasing order of boiling points of the following alcohols is

I. Pentan-1-ol II. 2-Pentanol
III. 3-Methyl butan-2-ol IV. 2-Methyl butan-2-ol.

(a) I > II > III > IV (b) I > III > II > IV
(c) II > I > III > IV (d) IV > III > II > I

23. Helical structure of protein is stabilised by

(a) peptide bond (b) hydrogen bond
(c) van der Waals force (d) dipole association.

24. Which of the following statements is not correct?

(a) The tertiary structure of proteins represents overall folding of the polypeptide chains.
(b) In globular proteins, nearly all the hydrophobic groups are hidden inside and the polar groups are present on the surface resulting into a spheroidal shape.
(c) Only hydrogen bonds are involved in the tertiary structure of proteins.
(d) Globular proteins are usually soluble in water.

25. Match the column I with column II and mark the appropriate choice.

	Column I		Column II
(A)	Methanol	(i)	Ethyl alcohol
(B)	Fermentation	(ii)	Heated copper at 573 K
(C)	Conversion of 2° alcohol to ketone	(iii)	Reaction of alkyl halide with sodium alkoxide
(D)	Williamson's synthesis	(iv)	Wood spirit

(a) (A) → (i), (B) → (iii), (C) → (ii), (D) → (iv)
(b) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
(c) (A) → (iv), (B) → (i), (C) → (ii), (D) → (iii)
(d) (A) → (iv), (B) → (ii), (C) → (iii), (D) → (i)

26. The boiling point of *p*-nitrophenol is higher than that of *o*-nitrophenol because

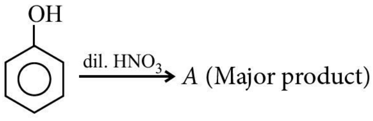
(a) intramolecular hydrogen bonding exists in *p*-nitrophenol
(b) $-NO_2$ group at *p*-position behaves in a different way from that at *o*-position
(c) *p*-nitrophenol has a lower molecular weight than *o*-nitrophenol
(d) there is intermolecular hydrogen bonding in *p*-nitrophenol.

27. Vitamin B_6 is known as

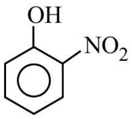
(a) pyridoxine (b) thiamine
(c) tocopherol (d) riboflavin.

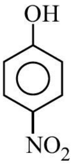
28. Two vitamins absorbed from intestine along with fats are

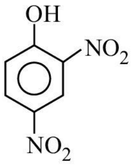
(a) A, D (b) A, B (c) A, C (d) D, B

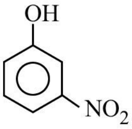
29. 

A is

(a) 

(b) 

(c) 

(d) 

30. Match the column I with column II and mark the appropriate choice.

	Column I		Column II
(A)	Williamson's synthesis	(i)	$C_6H_5OH + CH_3COCl$ in presence of pyridine
(B)	ROR'	(ii)	$C_2H_5ONa + C_2H_5Br$
(C)	*p*-Nitrophenol	(iii)	Unsymmetrical ether
(D)	Acetylation	(iv)	Intermolecular hydrogen bonding

(a) (A) → (i), (B) → (iii), (C) → (ii), (D) → (iv)
(b) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)
(c) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
(d) (A) → (iv), (B) → (i), (C) → (ii), (D) → (iii)

31. Nucleotides and nucleosides mainly differ from each other in
(a) presence of phosphate units
(b) presence of base units
(c) presence of nucleic acids
(d) none of the above.

32. The correct order of acidic strength of the following substituted phenols in water at 25°C is
(a) *p*-nitrophenol < *p*-fluorophenol < *p*-chlorophenol
(b) *p*-chlorophenol < *p*-fluorophenol < *p*-nitrophenol
(c) *p*-fluorophenol < *p*-chlorophenol < *p*-nitrophenol
(d) *p*-fluorophenol < *p*-nitrophenol < *p*-chlorophenol.

33. The main point of difference between DNA and RNA is
(a) presence of thymine in DNA and RNA

PUBLIC NOTICE

CUET 2023

National Testing Agency has been mandated by the **Ministry of Education and UGC** to conduct Common University Entrance Test (CUET) for admission into **Undergraduate Programmes** in **Central Universities under Ministry of Education, and other participating Universities / Institutions / Organizations / Autonomous Colleges**.

CUET (UG) will provide a **single window opportunity to students seeking admission in any of the Central Universities (CUs) or other participating organizations (including State Universities, Deemed and Private Universities) across the Country**.

For the Academic Session **2023-24, CUET (UG) – 2023** will be conducted in the **Computer Based Test (CBT) mode** as per the details given below :

Online Submission of Application Form	**09 February to 12 March 2023 (Up to 09:00 P.M.)**
Last date of successful transaction of fee through Credit / Debit Card / Net-Banking / UPI	**12 March 2023 (up to 11:50 P.M.)**
Correction in Particulars	**15 March to 18 March 2023 (Up to 11:50 P.M.)**
Announcement of the City of Examination	**30 April 2023**
Downloading of Admit Cards from the NTA website	**Second week of the May 2023**
Date of Examination	**21 May 2023 onwards**
Display of Recorded Responses and Answer Keys	To be announced later on the website
Website(s)	www.nta.ac.in, https://cuet.samarth.ac.in/
Declaration of Result on the NTA website	*To be announced later on the website*

The details of the programmes offered by Central Universities (CUs) and other participating Universities / Organizations are available on their respective websites as well as on https://cuet.samarth.ac.in/ **Candidates must carefully refer to the eligibility requirements of the programmes offered by various Central Universities and participating Universities / Organizations in this regard**.

The CUET (UG) - 2023 will be conducted in **13 languages** i.e. **English, Hindi, Assamese, Bengali, Gujarati, Kannada, Malayalam, Marathi, Odia, Punjabi, Tamil, Telugu, and Urdu**.

For CUET (UG) - 2023, the following is the scheme of examination :

Section	Subjects/ Tests	Questions to be Attempted
Section 1A - Languages	There are 13 different languages. Any of these languages may be chosen.	40 questions to be attempted out of 50 in each language
Section 1B - Languages	There are 20 Languages. Any of these languages may be chosen.	
Section 2 - Domain Specific Subject	There are 27 Domain specific subjects being offered under this section. A candidate may choose any subject as desired by the applicable University/ Organization.	35/40 Questions to be attempted out of 45/50
Section 3 - General Test	For any such undergraduate programme / programmes being offered by Universities where a General Test is being used for admission.	50 Questions to be attempted out of 60

Note:
1. *From the above subjects / languages, the* ***candidate can choose maximum of 10 subjects from all three Section.***
2. ***Examination will be conducted on multiple days in three shifts, depending on the number of Candidates and Subject choices.***

In case any candidate faces difficulty in applying for **CUET (UG) – 2023**, he/she may contact **011 - 40759000 / 011 - 69227700** or e-mail at **cuet-ug@nta.ac.in**. The candidates are also advised to be in touch with the NTA website(s) www.nta.ac.in and https://cuet.samarth.ac.in/ for the latest updates regarding the exam.

(b) presence of deoxyribose and thymine in DNA, ribose and uracil in RNA

(c) presence of ribose and thymine in DNA, deoxyribose and uracil in RNA

(d) presence of deoxyribose in DNA and ribose in RNA.

34. **Statement-I :** The two strands of DNA are complementary to each other.

Statement-II : Adenine specifically forms hydrogen bonds with guanine whereas cytosine forms hydrogen bonds with thymine.

(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.

(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.

(c) Statement-I is correct but statement-II is wrong.

(d) Statement-I is wrong but statement-II is correct.

35. **Statement-I :** The relative ease of dehydration of alcohols follow the following order :

Tertiary > Secondary > Primary

Statement-II : Formation of carbocation is the slowest step of the reaction.

(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.

(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.

(c) Statement-I is correct but statement-II is wrong.

(d) Statement-I is wrong but statement-II is correct.

36. Williamson's synthesis of preparing dimethyl ether is a/an

(a) electrophilic substitution

(b) S_N1 reaction

(c) electrophilic addition

(d) S_N2 reaction

37. Consider the following reaction,

$$\text{Phenol} \xrightarrow{\text{Zn dust}} X \xrightarrow[\text{anhyd. AlCl}_3]{\text{CH}_3\text{Cl}} Y \xrightarrow[\Delta]{\text{alkaline KMnO}_4} Z$$

The product Z is

(a) benzaldehyde (b) benzoic acid

(c) benzene (d) toluene.

38. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	Pentose sugar in DNA	(i)	Ascorbic acid
(B)	Nucleic acid	(ii)	Uracil
(C)	RNA	(iii)	Genetic material
(D)	Vitamin	(iv)	Furanose structure

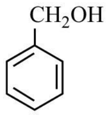
(a) (A) → (iv), (B) → (iii), (C) → (ii), (D) → (i)

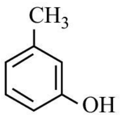
(b) (A) → (iii), (B) → (ii), (C) → (iv), (D) → (i)

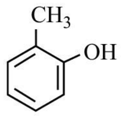
(c) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)

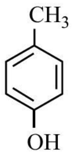
(d) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)

39. Which of the following compounds will give tribromo derivative on treatment with bromine water?

(a)


(b)


(c)


(d)


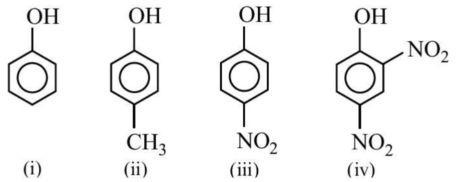
TRIO ANSWERS FEBRUARY 2023

The three trio are :

CONCENTRATION
TITRATION
CONFIGURATION
ENTROPY
DISPROPORTIONATION
EUTROPHICATION
ABSORPTION
CHEMISORPTION
SORBITOL

***Winners :** Sushanta Dhibar, Kaushikkumar Kevadiya, Tanishqa Evereen Tafannoom, Tapadyuti Choudhury, Shreya Kumari*

40. The correct order of strength of acidity of the following compounds is



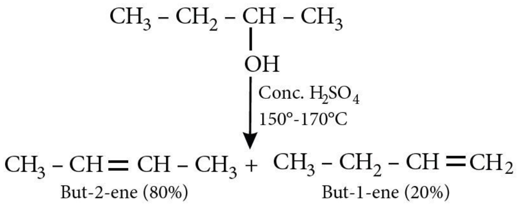
(a) (ii) > (i) > (iii) > (iv) (b) (i) > (ii) > (iii) > (iv)
(c) (iv) > (iii) > (ii) > (i) (d) (iv) > (iii) > (i) > (ii)

Case I : Read the given passage and answer the questions from 41 to 45.

Dehydration of alcohols is a β-elimination reaction in which C – O bond is cleaved along with loss of proton from β-position. Reaction takes place by heating alcohol with protonic acid such as H_2SO_4 or H_3PO_4 or catalysts such as alumina or anhydrous zinc chloride.

$$CH_3CH_2-OH \xrightarrow[150°-170\ °C]{\text{Conc. } H_2SO_4} CH_2=CH_2 + H_2O$$

Alkene formation takes place according to Saytzeff's rule.



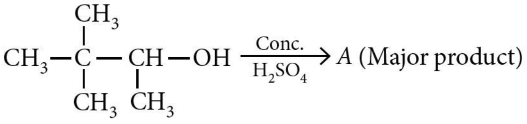
$$\begin{array}{c} CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{C}H}-CH_3 \\ \Big\downarrow {\scriptsize \begin{array}{l}\text{Conc. } H_2SO_4 \\ 150°\text{-}170°C\end{array}} \\ \underset{\text{But-2-ene (80\%)}}{CH_3-CH=CH-CH_3} + \underset{\text{But-1-ene (20\%)}}{CH_3-CH_2-CH=CH_2} \end{array}$$

Reaction mechanism involves the formation of carbocation intermediate thus, rearrangements may take place wherever possible by alkyl shift, hydride shift or ring expansion.

The following questions are multiple choice questions. Choose the most appropriate answer :

41. During the dehydration of alcohols to alkenes by heating with conc. H_2SO_4, the initiating step is
(a) elimination of water
(b) protonation of an alcohol molecule
(c) formation of an ester
(d) formation of carbocation.

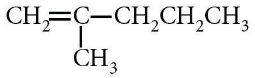
42.



$$CH_3-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-\underset{\displaystyle CH_3}{\underset{|}{C}H}-OH \xrightarrow[H_2SO_4]{\text{Conc.}} A \text{ (Major product)}$$

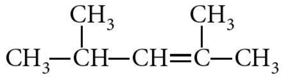
Major product A is
(a) $(CH_3)_3C-CH=CH_2$
(b) $(CH_3)_2C=C(CH_3)_2$

(c)



$$CH_2=\underset{\displaystyle CH_3}{\underset{|}{C}}-CH_2CH_2CH_3$$

(d)



$$CH_3-\overset{\displaystyle CH_3}{\overset{|}{C}H}-CH=\overset{\displaystyle CH_3}{\overset{|}{C}}-CH_3$$

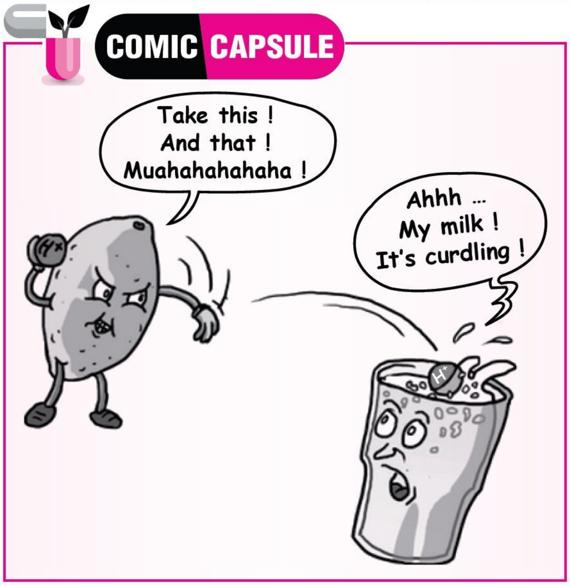
43. When *neo*-pentyl alcohol is treated with H_2SO_4, a mixture of two alkenes (85 : 15) is formed. Which statement is correct about these alkenes?
(a) Both give same major product with HBr.
(b) Both give same product (major) with HBr/R_2O_2/light.
(c) The alkene which is formed in 85% concentration has higher heat of hydrogenation than the other one obtained in 15% concentration.
(d) Both give same product on ozonolysis.

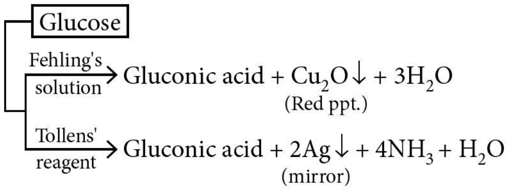
44. Which of the following can work as a dehydrating agent for alcohols to yield alkenes?
(a) Conc. H_2SO_4 (b) Conc. H_3PO_4
(c) Anhydrous $ZnCl_2$ (d) All of these

45. Dehydration of glycerol gives
(a) propane (b) propene
(c) acrolein (d) benzene.

Case II : Read the given passage and answer the questions from 46 to 50.

Carbohydrates which reduce Tollens' reagent (ammoniacal silver nitrate) and Fehling's solution are called reducing sugars while those which do not reduce these are called non-reducing sugars.


COMIC CAPSULE
Take this ! And that ! Muahahahahaha !
Ahhh ... My milk ! It's curdling !
H+
H+



$$\text{Glucose} \xrightarrow[\text{solution}]{\text{Fehling's}} \text{Gluconic acid} + \underset{\text{(Red ppt.)}}{Cu_2O\downarrow} + 3H_2O$$

$$\text{Glucose} \xrightarrow[\text{reagent}]{\text{Tollens'}} \text{Gluconic acid} + \underset{\text{(mirror)}}{2Ag\downarrow} + 4NH_3 + H_2O$$

The following questions are multiple choice questions. Choose the most appropriate answer :

46. Sucrose is not a reducing sugar since
(a) it is chemically stable
(b) it contains no free aldehyde or keto group adjacent to $\rangle$CHOH group
(c) it is built up of a fructose unit
(d) it is optically active.

47. Glucose gives silver mirror test with Tollens' reagent. It shows the presence of
(a) acidic group (b) alcoholic group
(c) aldehydic group (d) ketonic group.

48. Which of the following is/are non-reducing sugar molecule(s)?
(i) Fructose (ii) Cellulose
(iii) Starch (iv) Lactose
(a) (ii) and (iii) (b) (i) and (iv)
(c) (iii) only (d) (i) and (ii)

49. Which of the following reagents cannot distinguish between glucose and fructose?
(a) Tollens' reagent (b) Fehling's solution
(c) Benedict's solution (d) All of these.

50. Which of the following does not give silver mirror test with Tollens' reagent?
(a) Sucrose (b) Glucose
(c) Fructose (d) Lactose

SOLUTIONS

1. (d): The general formula of alcohols is $C_nH_{2n+2}O$ *e.g.*, C_2H_5OH or C_2H_6O.

2. (b) **3. (b)**

4. (b): Such isomers *i.e.*, α-form and β-form which differ only in the configuration of the hydroxyl group at C_1 are called anomers.

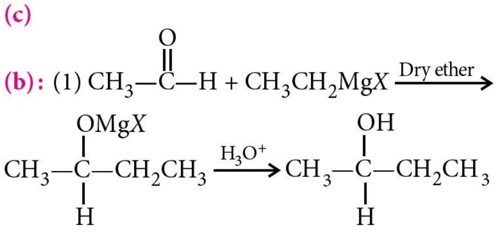
5. (c) : Furanose ring is found in the fructose unit of cane sugar. In cane sugar, the fructose molecule has a five-membered ring structure (furanose ring).

6. (c)

7. (d): Aldohexoses exist in 2^4 (16) optical forms as they have four chiral centres.

8. (c)

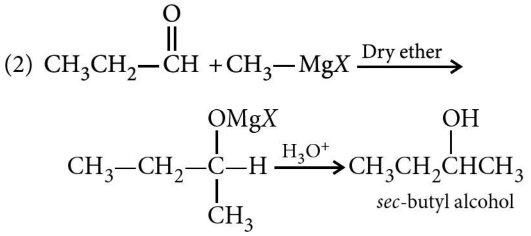
9. (b): (1)



$$CH_3-\overset{O}{\overset{\|}{C}}-H + CH_3CH_2MgX \xrightarrow{\text{Dry ether}} CH_3-\underset{H}{\overset{OMgX}{C}}-CH_2CH_3 \xrightarrow{H_3O^+} CH_3-\underset{H}{\overset{OH}{C}}-CH_2CH_3$$

sec-butyl alcohol

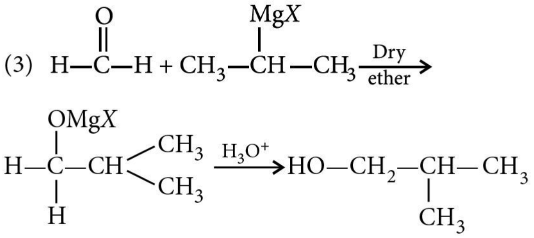
(2)



$$CH_3CH_2-\overset{O}{\overset{\|}{C}}H + CH_3-MgX \xrightarrow{\text{Dry ether}} CH_3-CH_2-\underset{CH_3}{\overset{OMgX}{C}}-H \xrightarrow{H_3O^+} CH_3CH_2\overset{OH}{C}HCH_3$$

sec-butyl alcohol

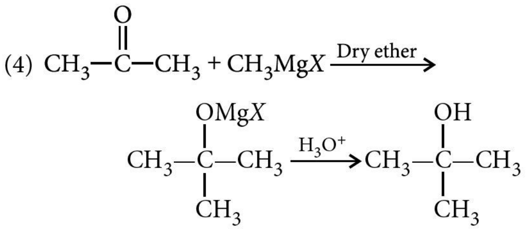
(3)



$$H-\overset{O}{\overset{\|}{C}}-H + CH_3-\overset{MgX}{CH}-CH_3 \xrightarrow[\text{ether}]{\text{Dry}} H-\underset{H}{\overset{OMgX}{C}}-CH\begin{matrix}CH_3\\CH_3\end{matrix} \xrightarrow{H_3O^+} HO-CH_2-\underset{CH_3}{CH}-CH_3$$

Isobutyl alcohol

(4)



$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CH_3MgX \xrightarrow{\text{Dry ether}} CH_3-\underset{CH_3}{\overset{OMgX}{C}}-CH_3 \xrightarrow{H_3O^+} CH_3-\underset{CH_3}{\overset{OH}{C}}-CH_3$$

tert-butyl alcohol

10. (a) **11. (a)**

12. (b)

13. (b): The β form of glucose is obtained by the crystallisation from hot and saturated aqueous solution at 371 K. Lactose is a reducing sugar.

14. (d) **15. (c)**

16. (d)

17. (c) : Hydroboration-oxidation reaction takes place according to anti-Markovnikov's rule, where the negative part of the addendum goes to the carbon containing maximum number of hydrogen atoms.

18. (a)

19. (b): Reduction of carboxylic acids with $LiAlH_4$ gives primary alcohol, $\rangle$CO group of carboxylic acid reduces to —CH_2— group.

20. (b)

21. (d): Denaturation results in the loss of both secondary and tertiary structures.

22. (a): Higher the branching, lower is the boiling point.

23. (b): The helical structure of proteins is stabilised by hydrogen bonds.

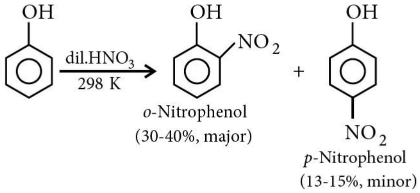
24. (c) **25. (c)**

26. (d)

27. (a): Vitamin B_6 is also known as pyridoxine.

28. (a): Vitamins A and D are fat soluble and thus absorbed along with fats.

29. (a) :



30. (c)

31. (a): Nucleotides have phosphate units.

32. (c)

33. (b): DNA has deoxyribose sugar; RNA has ribose sugar with three bases common as adenine, guanine and cytosine. DNA has fourth base thymine; RNA has uracil.

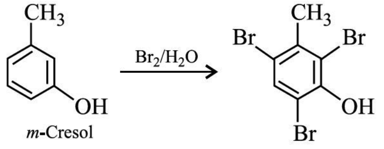
34. (c) : Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.

Due to specific pairing of bases, the two strands are complementary.

35. (a) **36. (d)**

37. (b) **38. (a)**

39. (b): Only *m*-cresol has two *ortho* and one *para*-positions free with respect to —OH group, hence it can form tribromo derivative.



40. (d)

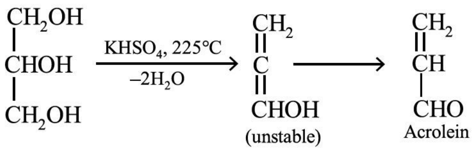
41. (b): The mechanism of dehydration of alcohols involves the following steps:

1. Formation of protonated alcohol
2. Formation of carbocation
3. Formation of alkene by elimination of a proton.

42. (b) **43. (a)**

44. (d): All the given reagents can act as dehydrating agents for alcohols.

45. (c) :



46. (b) **47. (c)**

48. (a): All polysaccharides are non-reducing sugars.

49. (d)

50. (a): All monosaccharides and disaccharides except sucrose reduce Tollens' reagent to shining silver mirror.

◆◆

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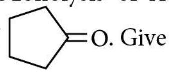
Exam on 30th April 2023

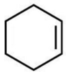
WB JEE

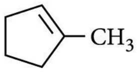
PRACTICE PAPER 2023

CATEGORY-I (Q. 1 to Q. 30)

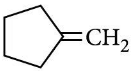
Carry-1 mark each. Only one option is correct. Negative marks : 1/4.

1. A compound (A) whose formula is C_6H_{10} reacts with H_2/Pt in excess to give a product C_6H_{12}, which does not decolourise Br_2/CCl_4. Ozonolysis of A gives 1 mol of HCHO and 1 mol of  Give the structure of A.

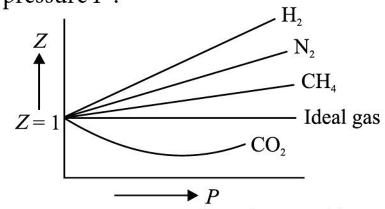
(a) 

(b) 

(c) $CH_3CH_2CH_2CH_2C{\equiv}CH$

(d) 

2. Consider the graph between compressibility factor Z and pressure P :



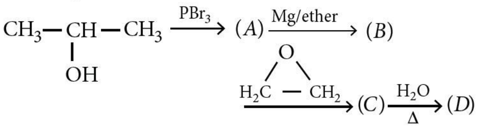
The correct increasing order of ease of liquefaction of the gases shown in the above graph is

(a) $H_2 < N_2 < CH_4 < CO_2$
(b) $CO_2 < CH_4 < N_2 < H_2$
(c) $H_2 < CH_4 < N_2 < CO_2$
(d) $CH_4 < H_2 < N_2 < CO_2$

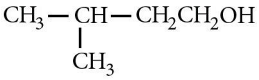
3. In which of the following pairs of species, the size of the first species is not more than the second species?

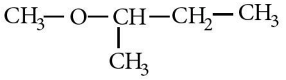
(a) Na^+, F^- (b) Fe^{2+}, Fe^{3+}
(c) Li, F (d) S, O

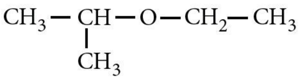
4. In the given reaction,



The final product (D) is

(a) 
$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2CH_2OH$

(b) 
$CH_3-O-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_3$

(c) 
$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-O-CH_2-CH_3$

(d) none of these.

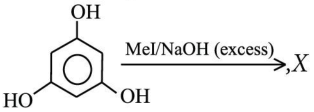
5. The radius of La^{3+} (Atomic number of La = 57) is 1.06 Å. Which one of the following given values will be closest to the radius of Lu^{3+} (Atomic number of Lu = 71)?

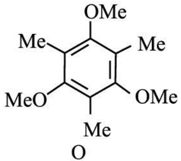
(a) 1.60 Å (b) 1.40 Å (c) 1.06 Å (d) 0.85 Å

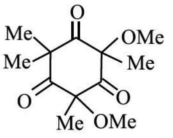
6. The number of tetrahedral voids present in 0.5 mole of *hcp* crystal structure are

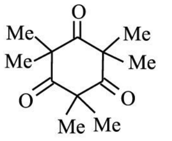
(a) 3.6×10^{23} (b) 9×10^{23}
(c) 3.6×10^{24} (d) 6.02×10^{23}

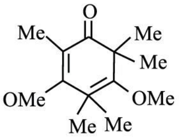
7. Identify the product 'X' in the following reaction.



(a) 

(b) 

(c) 

(d) 

8. A colloidal solution is subjected to an electric field. The colloidal particles move towards the anode, coagulation of the same colloidal solution is studied using NaCl, $BaCl_2$ and $AlCl_3$ solution. The coagulating power is

(a) $NaCl > AlCl_3 > BaCl_2$
(b) $AlCl_3 > BaCl_2 > NaCl$
(c) $NaCl > BaCl_2 > AlCl_3$
(d) $BaCl_2 > NaCl > AlCl_3$

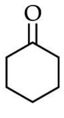
9. Diethyl ether on heating with excess of conc. HI gives two moles of
(a) ethanol
(b) 1-bromo-2-butene
(c) ethyl iodide
(d) methyl iodide.

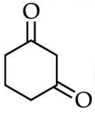
10. Velocity of the electron in 2nd orbit of hydrogen is x. What is the velocity of the electron in 1st orbit of Li^{2+} ion?
(a) $\frac{2}{3}x$
(b) $\frac{3}{2}x$
(c) $4x$
(d) $6x$

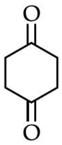
11. Consider the following complexes :
(i) K_2PtCl_6
(ii) $PtCl_4{\cdot}2NH_3$
(iii) $PtCl_4{\cdot}3NH_3$
(iv) $PtCl_4{\cdot}5NH_3$
Electrical conductances of aqueous solutions (i), (ii), (iii) and (iv) are respectively
(a) 256, 0, 97, 404
(b) 404, 0, 97, 256
(c) 256, 97, 0, 404
(d) 404, 97, 256, 0

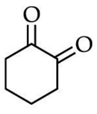
12. For the gaseous phase reaction, $2A + B \rightleftharpoons 2C + D$, initially there are 2 moles each of A and B. If 0.4 mol of D is present at equilibrium at a given T and P. The incorrect relationship is
(a) $P_A < P_B$ and $P_D < P_C$
(b) $P_A = P_C$ and $P_B = P_D$
(c) $P_C = 2P_D$ and $P_A = 3P_B/4$
(d) $P_A > P_D$ and $P_B > P_C$

13. Which of the following has the largest value of dissociation constant, K_a?

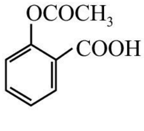
(a) 

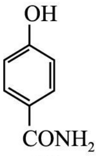
(b) 

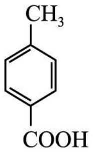
(c) 

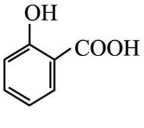
(d) 

14. Which of the following compounds represents an analgesic?

(a) 

(b) 

(c) 

(d) 

15. A mixture of nitrogen and water vapours is admitted to a flask at 760 torr which contains a sufficient solid drying agent. After long time, the pressure attained a steady value of 722 torr. If the experiment is done at 27° C and drying agent increases in mass by 0.9 g, what is the volume of the flask? Neglect any possible vapour pressure of drying agent and volume occupied by drying agent.
(a) 443.34 L
(b) 246.3 L
(c) 12.315 L
(d) 24.63 L

16. In which condition, adsorption will not take place?
(a) When ΔH is negative.
(b) When ΔH is positive and ΔS is positive.
(c) When ΔH is positive and ΔS is negative.
(d) When ΔG is negative.

17. A particle A moving with a certain velocity has a de Broglie wavelength of 1 Å.If particle B has mass 25% of that of A and velocity 75% of that of A, then the de Broglie wavelength of B will be approximately
(a) 1 Å
(b) 5.3 Å
(c) 3 Å
(d) 0.2 Å

18. In which of the following compounds is iron in its least oxidation state?
(a) $K_3[Fe(OH)_6]$
(b) $K_2[FeO_4]$
(c) $FeSO_4{\cdot}(NH_4)_2SO_4{\cdot}6H_2O$
(d) $[Fe(CN)_6]^{3-}$

19. Number of water molecules in the drop of water, if 1 mL of water has 20 drops and A is Avogadro's number, is
(a) $0.5\,A/18$
(b) $0.05\,A$
(c) $0.5\,A$
(d) $0.05\,A/18$

20. The $t_{1/2}$ for ^{14}C among the given compounds is
(i) $^{14}CO_2$
(ii) $^{14}C_6H_{12}O_6$
(iii) Coal containing ^{14}C
(iv) Cellulose containing ^{14}C
(a) more in $^{14}CO_2$
(b) more in coal containing ^{14}C
(c) more in $^{14}C_6H_{12}O_6$
(d) same in all species.

21. The proportion of hexamethylenediamine and adipic acid used in the preparation of nylon-6,6 is
(a) 1 : 2
(b) 1 : 1
(c) 2 : 1
(d) 2 : 3

22. A salt MA_2 ionises as $MA_2 \rightleftharpoons M^{2+} + 2A^-$
It was found that a given aqueous solution of the salt had the same depression in freezing point as solution of glucose of twice the molality. The apparent degree of ionisation of the salt is
(a) 0.25
(b) 0.33
(c) 0.50
(d) 0.67

23. Two samples of DNA, *A* and *B* have melting points 340 K and 350 K respectively. This is because
(a) *B* has more GC content than *A*
(b) *A* has more GC content than *B*
(c) AT base pair is more stable than CG base pair
(d) both have same AT content.

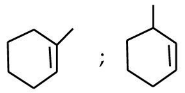
24. Phosphine is not obtained by the reaction when
(a) white P is heated with NaOH
(b) red P is heated with NaOH
(c) Ca_3P_2 reacts with water
(d) P_4O_6 is boiled with water.

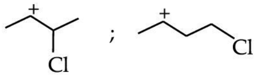
25. In a combination of NO_3^-, Br^- and I^- present in a mixture, Br^- and I^- interfere in the ring test for NO_3^-. These are removed by adding a solution of
(a) $AgNO_3$ (b) Ag_2SO_4
(c) Ag_2CO_3 (d) none of these.

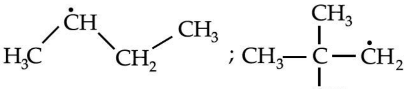
26. When H_2O_2 is shaken with an acidified solution of $K_2Cr_2O_7$ in presence of ether, the ethereal layer turns blue due to the formation of
(a) Cr_2O_3 (b) CrO_4^{2-}
(c) $Cr_2(SO_4)_3$ (d) CrO_5

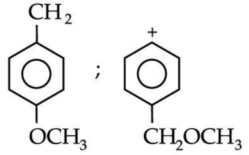
27. Which of the following species in pairs have same shape and same bond order?
NO_2^-, CO_2, and O_3
(a) NO_2^-, CO_2 (b) CO_2, O_3
(c) NO_2^-, O_3 (d) NO_2^-, CO_2, O_3

28. In which of the following pairs, the second member is more stable than first?

(a) 

(b) 

(c) 

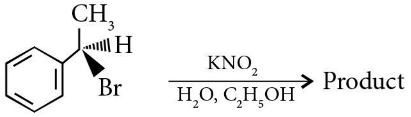
(d) 

29. Mark the incorrect statement.
(a) The chemical reactions of H_2SO_4 are result of its ability to act as an oxidising agent.
(b) Dilution of oleum with water gives H_2SO_4.
(c) The key step in the manufacture of H_2SO_4 is the catalytic reduction of SO_2.
(d) H_2SO_4, because of its low volatility can be used to manufacture more volatile acids from their corresponding salts.

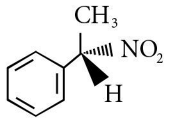
30. On passing a current of 1.0 ampere for 16 min and 5 seconds through 1 L solution of $CuCl_2$, all copper ions of the solution was deposited at cathode. The molarity of $CuCl_2$ solution was
(a) 0.1 M (b) 0.01 M
(c) 0.005 M (d) 0.2 M

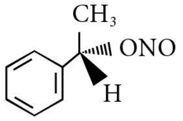
CATEGORY-II (Q. 31 to Q. 35)

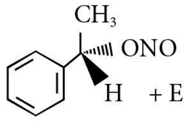
Carry-2 marks each. Only one option is correct. Negative marks : 1/2.

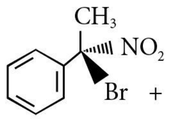
31. 

The main product is

(a) 

(b) 

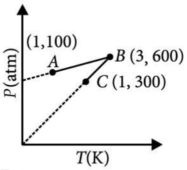
(c)  + Enantiomer

(d)  + Enantiomer

32. Ethanol-water mixture has 46 g ethanol in 100 g mixture. By a suitable technique volatile component goes off. Thus,
(a) 3 mol of non-volatile component are left
(b) 9 N_A atoms of non-volatile component are left
(c) 9 N_A atoms of volatile component are separated
(d) all of these are correct.

33. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotised and then heated with cuprous bromide. The reaction mixture so formed contains
(a) mixture of *o*- and *m*-bromotoluenes
(b) mixture of *o*- and *p*-bromotoluenes
(c) mixture of *o*- and *p*-dibromobenzenes
(d) mixture of *o*- and *p*-bromoanilines.

34. One mole of an ideal gas is subjected to a two step reversible process (*A*–*B* and *B*–*C*). The pressure at *A* and *C* is same. Mark the correct statements.



(a) Work involved in the path *AB* is zero.
(b) Volume of gas at *A* = volume of gas at *B*.
(c) Volume of gas at *C* = 3 × volume of gas at *A*.
(d) Volume of gas at *B* is 25 litres.

35. An electric current is passed through an aqueous solution of a mixture of alanine (isoelectric point 6.0), glutamic acid (3.2) and arginine (10.7) buffered at pH 6. What is the fate of the three acids?

(a) Glutamic acid migrates to anode at pH 6. Arginine is present as a cation and migrates to the cathode. Alanine in a dipolar ion remains uniformly distributed in solution.
(b) Glutamic acid migrates to cathode and others remain uniformly distributed in solution.
(c) All three remain uniformly distributed in solution.
(d) All three move to cathode.

CATEGORY-III (Q. 36 to Q. 40)

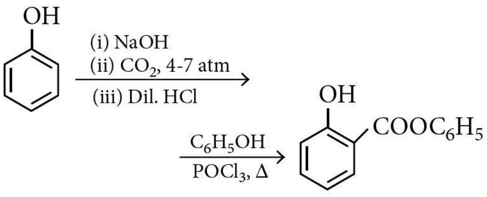
Carry-2 marks each. One or more options are correct. No negative marks.

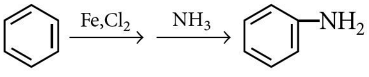
36. If a graph is plotted between log*V* and log*T* for 2 moles of a gas at constant pressure of 0.0821 atm, then which of the following statements are correct?

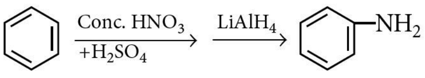
(a) The curve is straight line with slope –1.
(b) The curve is straight line with slope + 1.
(c) The intercept on *y*-axis is equal to 2.
(d) The intercept on *y*-axis is equal to 0.3010.

37. Choose the incorrect reactions.

(a) $PhCOOH \xrightarrow[\text{Conc. } H_2SO_4,\ \Delta]{N_3H} \xrightarrow[H^+]{PhN_2^+Cl^-}$ *p*-aminoazo benzene

(b)


(c)


(d)


38. If for a first order reaction, the values of *A* and E_a are 4×10^{13} sec^{-1} and 98.6 kJ/mol respectively, then at what temperature will its half-life period be 10 minutes?

(a) 330 K (b) 33°C
(c) 57°C (d) 311.15 K

39. Consider the following statements and select the correct option:

(a) K_{sp} of $Fe(OH)_3$ in aqueous solution is 3.8×10^{-38} at 298 K. The concentration of Fe^{3+} will increase when H^+ ion concentration decreases.
(b) In a mixture of NH_4Cl and NH_4OH in water, a further amount of NH_4Cl is added. The pH of the mixture will decrease.
(c) An aqueous solution of each of the following salts (NH_4I, HCOOK) will be basic, acidic respectively.
(d) In the reaction, $I_2 + I^- \rightarrow I_3^-$, the Lewis base is I^-.

40. The product (*A*) of following reaction :

$$CH_3COOH \xrightarrow[2.\ \Delta]{1.\ Ca(OH)_2} (A)$$

(a) reduces Fehling's solution
(b) forms an oxime
(c) does not react with Tollens' reagent
(d) forms chloretone.

Form IV

1. Place of Publication : New Delhi
2. Periodicity of its Publication : Monthly
3. Printer's Name : HT Media Ltd.
3a. Publisher's Name : MTG Learning Media Pvt. Ltd.
Nationality : Indian
Address : 406, Taj Apartment,
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Nationality : Indian
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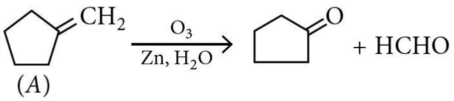
Centre, Gurugram,
Haryana - 122002
5. Name and address of individuals who own the newspapers and partners or shareholders holding more than one percent of the total capital : Mahabir Singh Ahlawat
64, National Media Centre,
Nathupur, Gurugram
: Krishna Devi
64, National Media Centre,
Nathupur, Gurugram
: Anil Ahlawat & Sons
19, National Media Centre,
Nathupur, Gurugram
: Anil Ahlawat
19, National Media Centre,
Nathupur, Gurugram

I, Mahabir Singh, authorised signatory for MTG Learning Media Pvt. Ltd. hereby declare that particulars given above are true to the best of my knowledge and belief.

For MTG Learning Media Pvt. Ltd.
Mahabir Singh
Director

SOLUTIONS

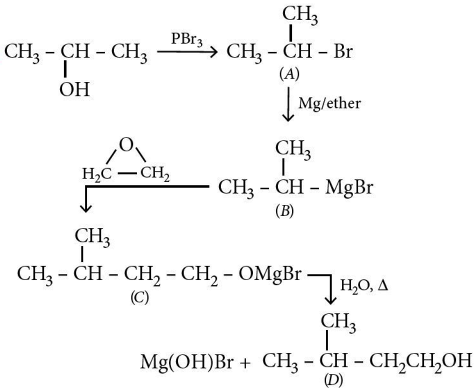
1. (d) :



2. (a) : Z is less than 1 means more compressible gases while $Z > 1$ means less compressible gases.

3. (a) : Na^+ and F^- are isoelectronic ions. Since, amongst isoelectronic ions, the size of the anion is larger than that of the cation, therefore, $Na^+ < F^-$.

4. (a) :



5. (d) : Due to lanthanide contraction, the ionic radii of Ln^{3+} (lanthanide ions) decreases from La^{3+} to Lu^{3+}. Thus, the lowest value (here 0.85 Å) is the ionic radius of Lu^{3+}.

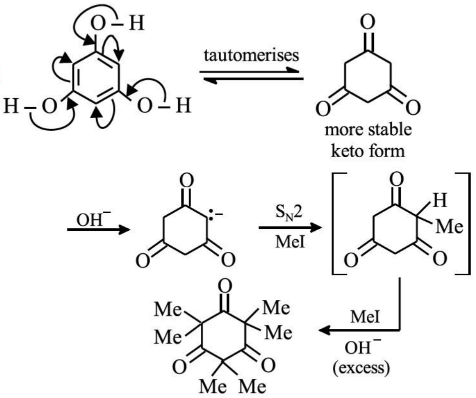
6. (c) : For *hcp*, $Z = 6$

$\therefore$ Tetrahedral voids $= 2Z = 2 \times 6 = 12$

Tetrahedral voids present in 0.5 mol $= 12 \times 0.5$ mol

$= 6N_A = 6 \times 6.02 \times 10^{23} = 3.6 \times 10^{24}$

7. (c) :



The more stable keto form gives α-alkylation reaction.

8. (b) : The colloidal particles are moving towards positive electrode (anode) *i.e.*, the particles are anions. For anions, coagulation increases with increase in positive charge of particles used for coagulation. The order of positive charge is $Al^{3+} > Ba^{2+} > Na^+$ thus, $AlCl_3 > BaCl_2 > NaCl$.

9. (c) : $\underset{\text{Diethyl ether}}{C_2H_5OC_2H_5} + \underset{\text{(excess)}}{2HI} \xrightarrow[\Delta]{373\text{ K}} \underset{\text{Ethyl iodide}}{2C_2H_5I} + H_2O$

10. (d) : $v \propto \frac{Z}{n}$; $\frac{v_1}{v_2} = \frac{Z_1}{n_1} \times \frac{n_2}{Z_2}$, $\frac{x}{v_2} = \frac{1}{2} \times \frac{1}{3} = \frac{1}{6} \Rightarrow v_2 = 6x$

11. (a) : Greater the number of ions, greater the conductance.

(i) $K_2[PtCl]_6 \rightleftharpoons \underbrace{2K^+ + [PtCl_6]^{2-}}_{\text{3 ions}}$

(ii) $PtCl_4{\cdot}2NH_3 \rightleftharpoons [Pt(NH_3)_2Cl_4] \longrightarrow$ no ion (zero)

(iii) $[Pt(NH_3)_3Cl_3]Cl \rightleftharpoons \underbrace{[Pt(NH_3)_3Cl_3]^+ + Cl^-}_{\text{2 ions}}$

(iv) $[Pt(NH_3)_5Cl]Cl_3 \rightleftharpoons \underbrace{[Pt(NH_3)_5Cl]^{3+} + 3Cl^-}_{\text{4 ions}}$ (maximum)

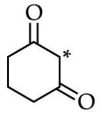
12. (b) : $2A + B \rightleftharpoons 2C + D$

	$2A$	B	$2C$	D
Initial conc.	2	2	0	0
At equilibrium	$2 - 2x$ $= 2 - 0.8$ $= 1.2$	$2 - x$ $= 2 - 0.4$ $= 1.6$	$2x$ $= 2 \times 0.4$ $= 0.8$	x $= 0.4$

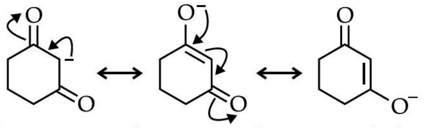
$p \propto n$,

$\therefore\ p_B > p_A > p_C > p_D$; $p_C = 2p_D$; $p_A = \frac{3p_B}{4}$

13. (b) :



It contains the most reactive methylene group (*) and resulting anion is stabilised by resonance.



14. (a) : 2-Acetoxybenzoic acid, commonly known as 'aspirin' acts as an analgesic.

15. (d) : $P_{H_2O} = 760 - 722 = \frac{38}{760}$ atm; $n_{H_2O} = \frac{0.9}{18}$

As $PV = nRT$

$V = \frac{nRT}{P} = \frac{0.9}{18} \times \frac{0.0821 \times 300}{38} \times 760$; $V = 24.63$ L

16. (c) : Adsorption will not take place when ΔH is positive and ΔS is negative because in this case, ΔG will become positive and for adsorption, ΔG must be negative.

17. (b) : $\lambda_A = \frac{h}{mv}$, $\lambda_B = \frac{h}{0.25m \times 0.75v}$

$\frac{\lambda_B}{\lambda_A} = \frac{1}{0.25 \times 0.75} = 5.3 \Rightarrow \lambda_B = 5.3\lambda_A = 5.3$ Å

18. (c) : In Mohr's salt, iron is in +2 oxidation state.

19. (d) : 1 drop of water = $\frac{1}{20}$ mL = $\frac{1}{20}$ g
($d_{H_2O} = 1\ \text{g mL}^{-1}$)

18 g of water = A molecules

$\therefore\ \frac{1}{20}$ g water = $\frac{A}{18} \times \frac{1}{20} = \frac{0.05A}{18}$ molecules.

20. (d) : $t_{1/2}$ is independent of all external factors and is constant for a given species.

21. (b) : In the preparation of Nylon-6,6, 1 mole of hexamethylene diamine reacts with 1 mole of adipic acid because hexamethylene diamine is a diacidic base and adipic acid is dibasic acid.

22. (c) : $\underset{1-\alpha}{MA_2} \rightleftharpoons \underset{\alpha}{M^{2+}} + \underset{2\alpha}{2A^-}$

$i = \frac{\text{Actual no. of particles in solution}}{\text{Number of particles taken}}$; $i = 1 + 2\alpha$

ΔT_f of $MA_2 = \Delta T_f$ of glucose

$i \cdot K_f \cdot m = K_f \cdot 2m \Rightarrow i = 2$

$1 + 2\alpha = 2 \Rightarrow 2\alpha = 1 \Rightarrow \alpha = 0.5$

23. (a) : DNA, B has higher melting point than DNA, A because B has more GC content than A.

Since, GC base pair having three H-bonds so it is more stable than AT base pair having two H-bonds.

24. (b) : Red P does not react with NaOH. Only white P reacts with NaOH or KOH to form PH_3.

25. (b) : $NO_3^- + Br^- + I^- + Ag_2SO_4 \longrightarrow$

$$\underbrace{AgBr + AgI}_{\text{ppt.}} + NO_3^- + SO_4^{2-}$$

Ag_2CO_3 does not dissolve in water.

26. (d) : Acidified $K_2Cr_2O_7$ solution reacts with hydrogen peroxide to give a deep blue solution due to the formation of peroxo compound CrO_5.

$K_2Cr_2O_7 + H_2SO_4 + 4H_2O_2 \rightarrow 2CrO_5 + K_2SO_4 + 5H_2O$

27. (c) : Isoelectronic species possess same shape and same bond order.

NO_2^- and O_3 are isoelectronic (24 electrons).

Thus NO_2^- and O_3 have same shape and bond order.

28. (b) : –Cl shows electron withdrawing effect (–I) and destabilizes carbocation.

29. (c) : The key step in the formation of sulphuric acid is catalytic oxidation of sulphur dioxide to sulphur trioxide with atmospheric oxygen.

30. (c) : $Cu^{2+} + 2e^- \longrightarrow Cu$

$2 \times 96500\ \text{C} \equiv 1$ mol Cu = 1 mol $CuCl_2$

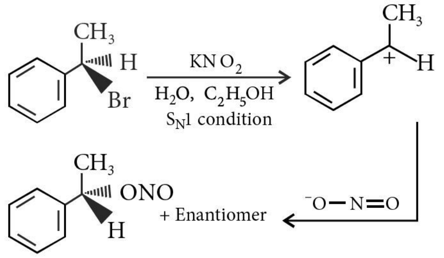
$Q = I \times t = 1 \times (60 \times 16 + 5) = 965$ C

By Faraday's first law, $\frac{W}{E} = \frac{It}{96500}$

$\therefore$ 965 C will deposit $\equiv \frac{965}{2 \times 96500} = \frac{1}{200}$ mol $CuCl_2$

$\therefore$ Molarity of $CuCl_2$ solution = $\frac{1}{200}$ mol L^{-1} = 0.005 M

31. (c) :



32. (d) : Volatile component of CH_3CH_2OH = 46 g

No. of moles = $\frac{46}{46}$ = 1 mol

1 mole of ethanol = N_A molecules = $9N_A$ atoms

Thus, (c) is correct.

Non-volatile component is H_2O = 54 g

No. of moles = $\frac{54}{18}$ = 3 moles

Thus, (a) is correct.

Non-volatile component of $H_2O = 3N_A$ molecules

$= 3 \times 3N_A$ atoms $= 9N_A$ atoms

Thus, (b) is correct.

33. (b) :

$$\begin{tikzcd}
\text{Toluene} \arrow[r, "HNO_3/H_2SO_4"] & \textit{o-}\text{ and }\textit{p-}\text{nitrotoluene} \arrow[d, "Sn/HCl"] \\
\textit{o-}\text{ and }\textit{p-}\text{toluene diazonium salts} \arrow[d, "CuBr"] & \textit{o-}\text{ and }\textit{p-}\text{toluidine} \arrow[l, "HNO_2/HCl"'] \\
\textit{o-}\text{ and }\textit{p-}\text{bromotoluene} &
\end{tikzcd}$$

34. (c) : As $PV = nRT$ or $V = \frac{nRT}{P}$

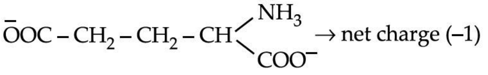
$V_A = \frac{1 \times R \times 100}{1} = 100R$; $V_B = \frac{1 \times R \times 600}{3} = 200R$

$V_C = \frac{1 \times R \times 300}{1} = 300\,R$

$\because$ $V_B > V_A$, so expansion of gas takes place.

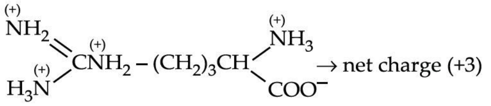
$V_B = 200 \times 0.0821 = 16.42$ L

35. (a) : At pH = 6, glutamic acid exists as a dianionic species.



$\overline{O}OC-CH_2-CH_2-CH\begin{matrix}\overset{(+)}{NH_3}\\ COO^-\end{matrix}$ → net charge (–1)

So it migrates to anode while arginine exists as cationic species.



(+) NH₂
(+) H₃N
(+) CNH₂ – (CH₂)₃CH
(+) NH₃
COO⁻
→ net charge (+3)

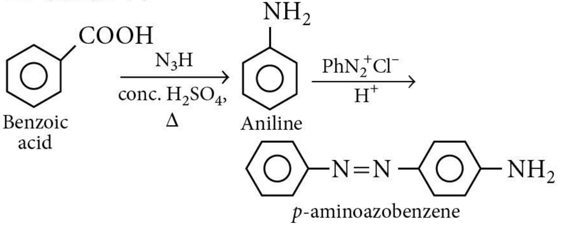
So, it migrates to cathode.

Alanine does not migrate to any electrode at its isoelectric point.

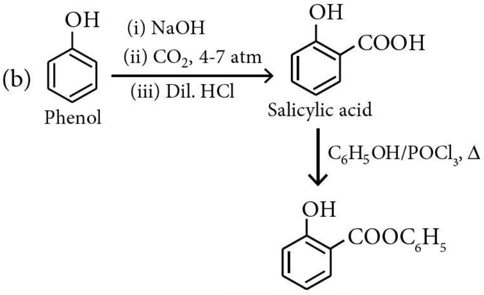
36. (b,d) : $PV = nRT$, $\log V = \log T + \log \frac{nR}{P}$; Slope = 1

$$\text{Intercept} = \log \frac{nR}{P} = \log \left[\frac{2 \times 0.0821}{0.0821}\right] = 0.3010$$

37. (c, d) : (a)

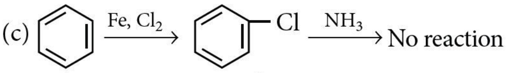


COOH
Benzoic acid
N₃H
conc. H₂SO₄, Δ
NH₂
Aniline
PhN₂⁺Cl⁻
H⁺
N=N
NH₂
p-aminoazobenzene

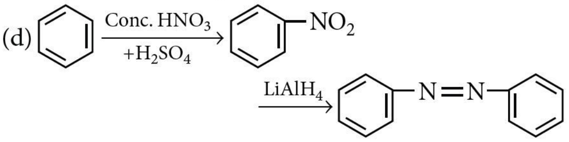


(b)
OH
Phenol
(i) NaOH
(ii) CO₂, 4-7 atm
(iii) Dil. HCl
OH
COOH
Salicylic acid
C₆H₅OH/POCl₃, Δ
OH
COOC₆H₅

Salol or phenylsalicylate



(c)
Fe, Cl₂
Cl
NH₃
No reaction



(d)
Conc. HNO₃
+H₂SO₄
NO₂
LiAlH₄
N=N

38. (d) : According to Arrhenius equation, $k = Ae^{-E_a/RT}$

$$\log k = \log A - \frac{E_a}{2.303RT} \quad \text{...(1)}$$

For a first order reaction, $t_{1/2} = \frac{0.693}{k}$

$t_{1/2} = 10 \text{ min} = 600 \text{ s}$

$$\therefore\ k = \frac{0.693}{600} = 1.155 \times 10^{-3} \text{ s}^{-1} = 11.55 \times 10^{-4} \text{ s}^{-1} \quad \text{...(2)}$$

Putting value of k from eq. (2) in eq. (1) we get,

$$\log (11.55 \times 10^{-4}) = \log (4 \times 10^{13}) - \frac{98.6 \times 10^{3}}{2.303 \times 8.314 \times T}$$

$\therefore\ T = 311.5$ K

39. (b, d): (a) If $[H^+]$ decreases, $[OH^-]$ increases.

$[\because\ [H^+][OH^-] = \text{constant}]$

Hence, reaction shifts to backward direction. Thus $[Fe^{3+}]$ will decrease.

(b) $NH_4OH \rightleftharpoons NH_4^+ + OH^-$; $NH_4Cl \rightarrow NH_4^+ + Cl^-$

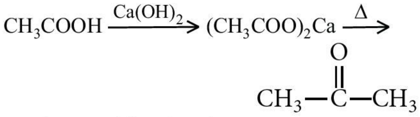
Since concentration of NH_4^+ ions increases, dissociation of NH_4OH is suppressed. Hence $[OH^-]$ decreases, pOH increases, thus pH decreases.

(c) $NH_4I + H_2O \rightleftharpoons \underset{\text{Weak base}}{NH_4OH} + \underset{\text{Strong acid}}{HI}$

$HCOOK + H_2O \rightleftharpoons \underset{\text{Weak acid}}{HCOOH} + \underset{\text{Strong base}}{KOH}$

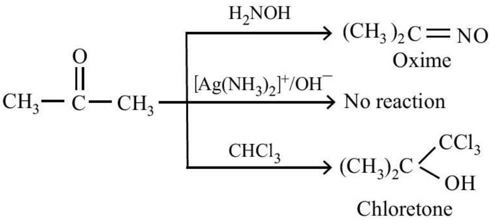
(d) I⁻ ion acts as Lewis base, *i.e.*, it can donate electron pair to some species.

40. (b, c, d) :



$$CH_3COOH \xrightarrow{Ca(OH)_2} (CH_3COO)_2Ca \xrightarrow{\Delta} CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$$

Ketones do not reduce Fehling's solution.

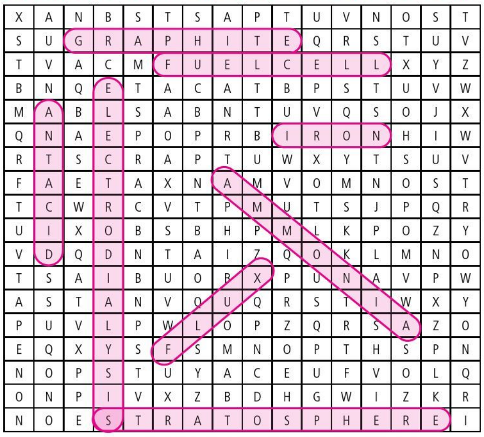


CH₃—C—CH₃
O
H₂NOH
(CH₃)₂C=NOH
Oxime
[Ag(NH₃)₂]⁺/OH⁻
No reaction
CHCl₃
(CH₃)₂C
CCl₃
OH
Chloretone

⁂

Winner : Kaushikkumar Kevadiya

SOLUTIONS TO FEBRUARY 2023 WORD GRID



X	A	N	B	S	T	S	A	P	T	U	V	N	O	S	T
S	U	G	R	A	P	H	I	T	E	Q	R	S	T	U	V
T	V	A	C	M	F	U	E	L	C	E	L	L	X	Y	Z
B	N	Q	E	T	A	C	A	T	B	P	S	T	U	V	W
M	A	B	L	S	A	B	N	T	U	V	Q	S	O	J	X
Q	N	A	E	P	O	P	R	B	I	R	O	N	H	I	W
R	T	S	C	R	A	P	T	U	W	X	Y	T	S	U	V
F	A	E	T	A	X	N	A	M	V	O	M	N	O	S	T
T	C	W	R	C	V	T	P	M	U	T	S	J	P	Q	R
U	I	X	O	B	S	B	H	P	M	L	K	P	O	Z	Y
V	D	Q	D	N	T	A	I	Z	Q	O	K	L	M	N	O
T	S	A	I	B	U	O	B	X	P	U	N	A	V	P	W
A	S	T	A	N	V	Q	U	Q	R	S	T	I	W	X	Y
P	U	V	L	P	W	L	O	P	Z	Q	R	S	A	Z	O
E	Q	X	Y	S	F	S	M	N	O	P	T	H	S	P	N
N	O	P	S	T	U	Y	A	C	E	U	F	V	O	L	Q
O	N	P	I	V	X	Z	B	D	H	G	W	I	Z	K	R
N	O	E	S	T	R	A	T	O	S	P	H	E	R	E	I

1. Electrodialysis
2. Fuel cell
3. Ammonia
4. Flux
5. Graphite
6. Stratosphere
7. Antacid
8. Iron

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Step 6
Online payment can be made via Paytm, Axis, IOB and other specified modes

Step 7
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Step 8
Details on the induction programme, date of reopening of the College, and schedule for classes are sent to your institutional email

Step 9
Classes begin and you can contact your HoD for further information

Step 10
Finally, you submit your Original Documents in Person

'Bring pollution norms in line with that of WHO'

Greenpeace India has urged Central Pollution Control Board (CPCB) to update Indian pollution standards following the norms of World Health Organization (WHO). Volunteers of Greenpeace, along with residents, gathered at the CPCB office on 3rd February and met officials to hand over a petition signed by over 10,000 citizens.

According to experts, stronger and updated standards will attract stricter action plans to tackle the problem of air pollution. India's annual concentration standards for pollutants continue to be 40 micrograms per cubic metres (ug/m3) for PM2.5, a figure eight times higher than WHO's standards of 5 ug/m3 for particulate matters.

Experts say updated standards will paint the real picture of the threat by showing how several Indian cities are lagging. "Studies say if cities like Delhi meet the WHO guidelines, the lifespan would increase by nine years, and premature deaths would be minimised. Right now, our acceptable pollutant concentrations are so high that even when the air quality index in cities like Delhi is poor, we don't consider it polluted," said Avinash Chanchal,manager, Greenpeace India. "Over 80% Indian cities are polluted, but cities are satisfied because they compare their pollution levels with national standards. Better, updated standards will be an eye opener, not just for Delhi, but for other cities as well," he added.

Ideally the standards should be revised every five years, but there is no such official mandate, Chanchal pointed out. Bhavreen Kandhari, environment activist and founder of NGO Warrior Moms, "We want to remind CPCB that when we achieve the WHO guidelines, we will save millions of lives,billions of rupees and future generations from the ravages of climate change and air pollution."

Officials at CPCB didn't respond despite multiple attempts. India last revised its national ambient air quality standards (NAAQS) in 2009, and after WHO revised its guidelines in 2021, the difference between the standards have widened.

Courtesy : The Times of India

Quiz CLUB

Unlock Your Knowledge!

1. The milky sap obtained from rubber tree is known as ________.
2. The use of chemicals for treatment of cancer is called ________.
3. The greater the pK_a value, the weaker the ________.
4. ________ are the biocatalysts which speed up the reactions in a biosystem.
5. The reactant which gets consumed first and limits the amount of product formed is called ________.
6. Two or more species of atoms that have equal number of neutrons are known as ________.
7. The laws of electrolysis were given by ________.
8. ________ is the most abundant isotope of hydrogen.
9. The formula of boric acid is ________.
10. The metal present in vitamin B_{12} is ________.
11. The compounds formed when hydrogen combines with *p*-block elements are called ________ hydrides.
12. The ________ law states that the heat energy changes remain constant irrespective of the way the reactant reacts in a particular reaction.
13. ________ is the measure of the randomness of the system.
14. A ________ is the location in an atom with no probability of finding an electron.
15. ________ is the naturally occurring heaviest element.
16. The number of hydrogen atoms in a glucose molecule is ________.
17. The hydrolysis of an ester with NaOH or KOH to produce alcohol and sodium or potassium salt of the acid is called ________.
18. The most reactive halogen is ________.
19. The region of atmosphere which is greatly affected by air pollution is ________.
20. The non-participation of n_s electrons in bond formation is said to be ________.

◆◆

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

TRIO

Here are the nine shuffled words containing 3 sets of trio. Complete these words by finding 3 sets of trio.

DIFF — — — TION
TETRA— — —RAL
CONT — — — TION
ESTERIFI— — — ION
OCTA— — —RAL
EMULSIFI— — —ION
EXT— — — TION
SOLIDIFI— — —ION
RHOMBO— — —RAL

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names will be published in next issue.

WORD GRID

Readers are
requested to send
their responses of
word grid.
Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

A	C	D	P	H	T	H	A	L	I	M	I	D	E	U	W
P	Q	R	T	S	L	Z	R	O	N	A	Q	E	V	S	T
B	H	R	I	D	T	H	E	I	N	E	X	C	O	S	M
E	Y	E	S	J	O	Y	T	Y	P	E	S	A	L	T	S
U	B	E	R	A	S	D	P	Q	L	T	S	R	D	A	C
A	R	B	C	E	F	R	S	K	N	M	O	B	I	R	D
B	I	R	D	Y	E	I	A	R	O	B	S	O	I	C	T
Z	D	A	S	D	L	D	P	Q	A	P	N	X	Y	H	G
L	I	O	N	B	E	E	R	E	A	D	Y	Y	E	A	R
O	S	W	A	L	I	S	N	E	I	G	T	L	I	O	N
L	A	D	Y	M	A	N	W	O	M	E	N	A	R	E	A
O	T	H	R	E	O	N	I	N	E	N	E	T	W	O	H
B	I	R	D	A	I	R	O	N	I	N	D	I	A	I	D
L	O	C	A	L	A	R	E	A	Y	O	U	O	B	A	G
K	N	O	W	N	I	A	M	R	E	A	D	N	O	S	T
B	E	C	A	U	S	E	Y	O	U	R	A	R	E	M	O
M	O	S	T	U	R	E	W	E	A	T	H	E	R	O	T
D	I	A	S	T	E	R	E	O	M	E	R	S	P	G	L

Clues

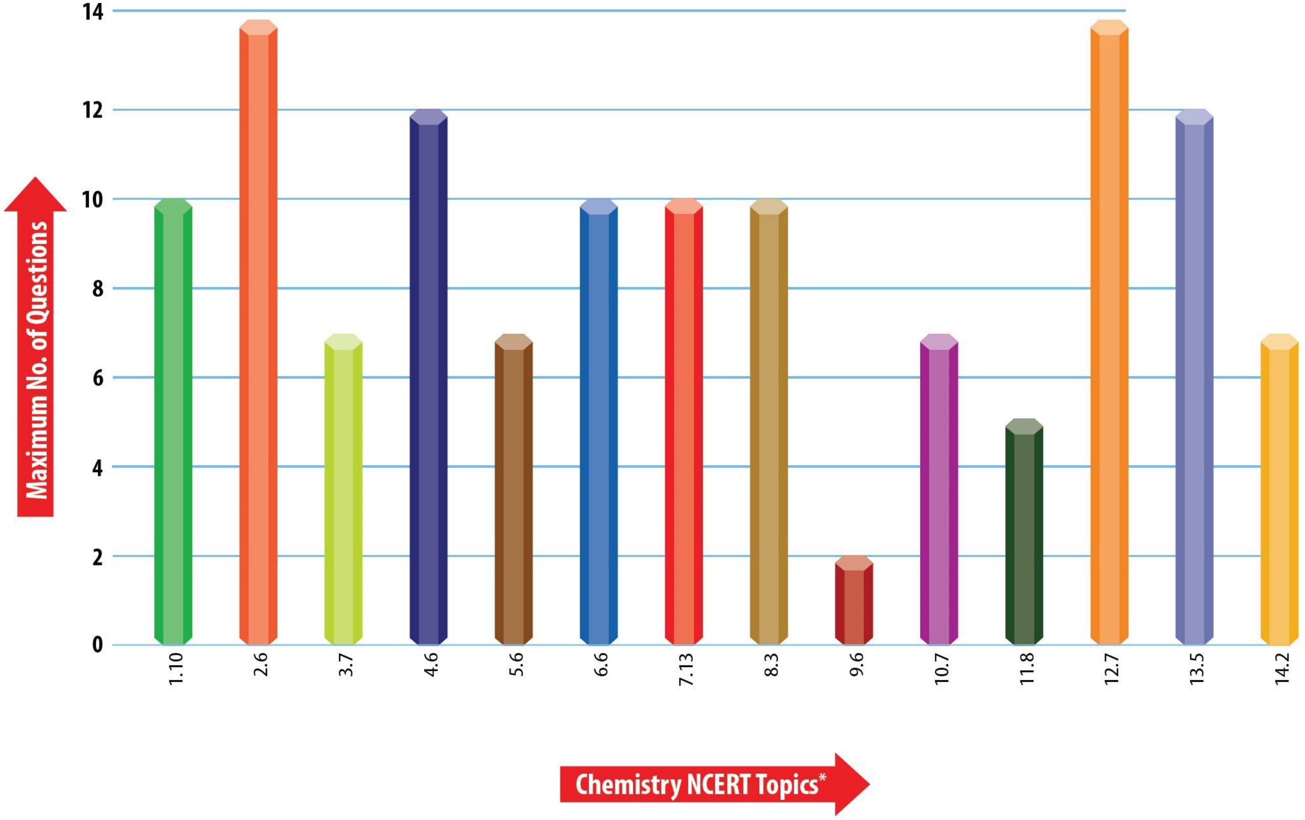
1. The process of intermixing of the orbitals of slightly different energies so as to redistribute their energies resulting in the formation of new set of orbitals of equivalent energies and shape.
2. An essential amino acid.
3. A polymer of α-glucose that consists of two components-amylose and amylopectin.
4. An organic compound used to convert an alkyl halide to primary amine.
5. The phenomenon which occurs due to the condensation of fog on the carbon particles present in the smoke due to combustion of fuels.
6. A chemical reaction that removes a carboxyl group and releases carbon dioxide.
7. Stereoisomers which are not mirror images of each other.
8. The binary compounds formed by hydrogen with other elements.

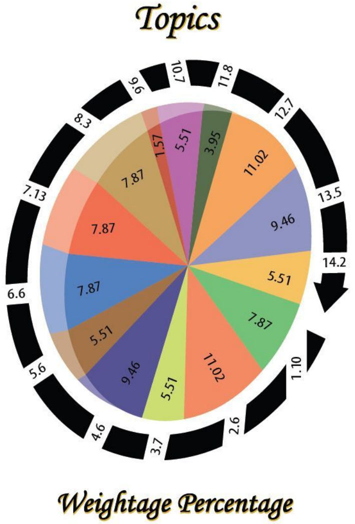
*Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.

Are You Ready for NEET?

Past 10 Years (2013-2022) Chapterwise and Topicwise Trend Analysis of NEET Questions

CLASS 11

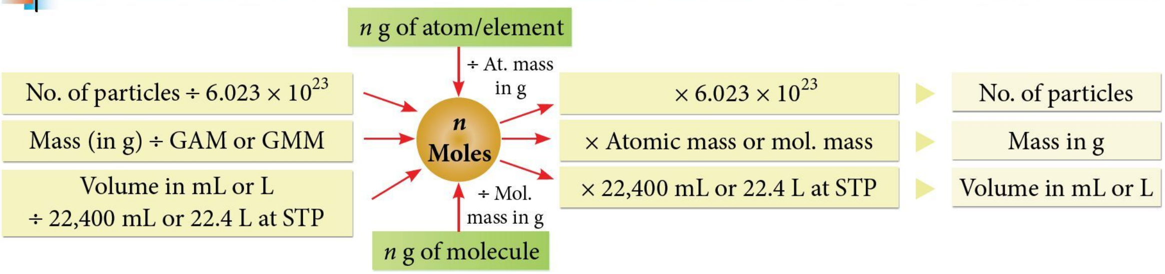




*These are the topics from where maximum number of questions have been asked in the past 10 years.

Chapter 1 : Some Basic Concepts of Chemistry

Mole Concept



n g of atom/element

÷ At. mass in g

No. of particles ÷ 6.023×10^{23}

Mass (in g) ÷ GAM or GMM

Volume in mL or L ÷ 22,400 mL or 22.4 L at STP

n Moles

÷ Mol. mass in g

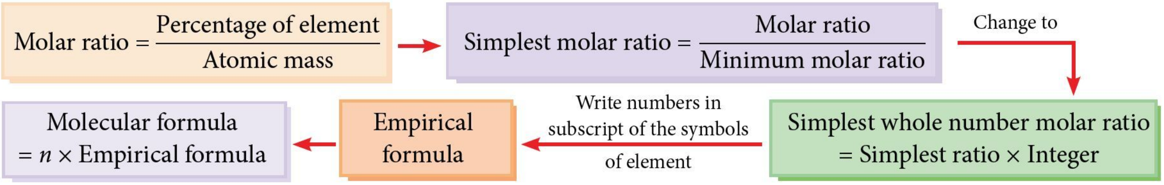
n g of molecule

$\times 6.023 \times 10^{23}$ → No. of particles

× Atomic mass or mol. mass → Mass in g

× 22,400 mL or 22.4 L at STP → Volume in mL or L

Determination of Empirical and Molecular Formulae



$$\text{Molar ratio} = \frac{\text{Percentage of element}}{\text{Atomic mass}}$$

$$\text{Simplest molar ratio} = \frac{\text{Molar ratio}}{\text{Minimum molar ratio}}$$

Change to

Simplest whole number molar ratio = Simplest ratio × Integer

Write numbers in subscript of the symbols of element

Empirical formula

Molecular formula = n × Empirical formula

Stoichiometry of Chemical Reactions

The reactant that is completely used up in a reaction is known as the **limiting reactant**. It is called the limiting reactant because it determines or limits the amount of products formed. The reactants that are not used up completely are called the **excess reactants**.

$$H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$$

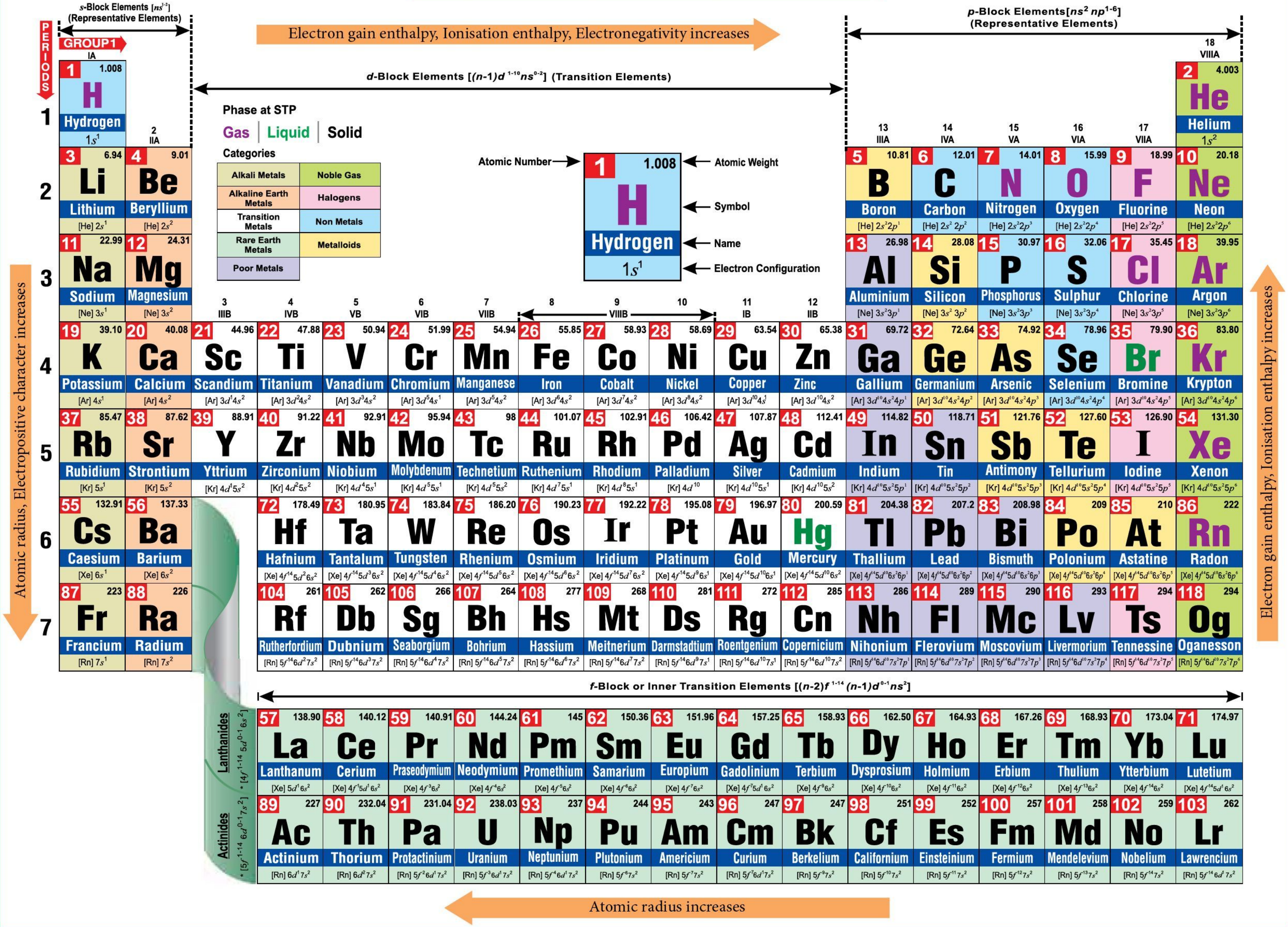
Experiment	Moles of reactants used		Moles of products formed		
	Hydrogen (H_2)	Chlorine (Cl_2)	Hydrogen chloride (HCl)	Unreacted hydrogen	Unreacted chlorine
A	1	1	2	0	0
	H H	Cl Cl	H Cl H Cl		
B	2	1	2	1	0
	H H H H	Cl Cl	H Cl H Cl	H H	
C	1	2	2	0	1
	H H	Cl Cl Cl Cl	H Cl H Cl		Cl Cl

A: All the reactants are used up completely.

B: **Excess hydrogen** is used. Hence, some hydrogen left unreacted. **In this case, chlorine is the limiting reactant.**

C: **Excess chlorine** is used. Hence, some chlorine left unreacted. **In this case, hydrogen is the limiting reactant.**

Long Form of Periodic Table and Periodic Trends


s-Block Elements [ns^{1-2}] (Representative Elements)
d-Block Elements [$(n-1)d^{1-10}ns^{0-2}$] (Transition Elements)
p-Block Elements [ns^2np^{1-6}] (Representative Elements)
f-Block or Inner Transition Elements [$(n-2)f^{1-14}(n-1)d^{0-1}ns^2$]
Electron gain enthalpy, Ionisation enthalpy, Electronegativity increases
Electron gain enthalpy, Ionisation enthalpy increases
Atomic radius, Electropositive character increases
Atomic radius increases
PERIODS
GROUP1
Atomic Number
Atomic Weight
Symbol
Name
Electron Configuration
1 1.008
H
Hydrogen
$1s^1$
Phase at STP
Gas | Liquid | Solid
Categories
Alkali Metals
Alkaline Earth Metals
Transition Metals
Rare Earth Metals
Poor Metals
Noble Gas
Halogens
Non Metals
Metalloids

PERIODS	GROUP1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.008 **H** Hydrogen $1s^1$																	2 4.003 **He** Helium $1s^2$
2	3 6.94 **Li** Lithium [He] $2s^1$	4 9.01 **Be** Beryllium [He] $2s^2$											5 10.81 **B** Boron [He] $2s^22p^1$	6 12.01 **C** Carbon [He] $2s^2 2p^2$	7 14.01 **N** Nitrogen [He] $2s^22p^3$	8 15.99 **O** Oxygen [He] $2s^22p^4$	9 18.99 **F** Fluorine [He] $2s^22p^5$	10 20.18 **Ne** Neon [He] $2s^22p^6$
3	11 22.99 **Na** Sodium [Ne] $3s^1$	12 24.31 **Mg** Magnesium [Ne] $3s^2$											13 26.98 **Al** Aluminium [Ne] $3s^23p^1$	14 28.08 **Si** Silicon [Ne] $3s^2 3p^2$	15 30.97 **P** Phosphorus [Ne] $3s^23p^3$	16 32.06 **S** Sulphur [Ne] $3s^23p^4$	17 35.45 **Cl** Chlorine [Ne] $3s^23p^5$	18 39.95 **Ar** Argon [Ne] $3s^23p^6$
4	19 39.10 **K** Potassium [Ar] $4s^1$	20 40.08 **Ca** Calcium [Ar] $4s^2$	21 44.96 **Sc** Scandium [Ar] $3d^14s^2$	22 47.88 **Ti** Titanium [Ar] $3d^24s^2$	23 50.94 **V** Vanadium [Ar] $3d^34s^2$	24 51.99 **Cr** Chromium [Ar] $3d^54s^1$	25 54.94 **Mn** Manganese [Ar] $3d^54s^2$	26 55.85 **Fe** Iron [Ar] $3d^64s^2$	27 58.93 **Co** Cobalt [Ar] $3d^74s^2$	28 58.69 **Ni** Nickel [Ar] $3d^84s^2$	29 63.54 **Cu** Copper [Ar] $3d^{10}4s^1$	30 65.38 **Zn** Zinc [Ar] $3d^{10}4s^2$	31 69.72 **Ga** Gallium [Ar] $3d^{10}4s^24p^1$	32 72.64 **Ge** Germanium [Ar] $3d^{10}4s^24p^2$	33 74.92 **As** Arsenic [Ar] $3d^{10}4s^24p^3$	34 78.96 **Se** Selenium [Ar] $3d^{10}4s^24p^4$	35 79.90 **Br** Bromine [Ar] $3d^{10}4s^24p^5$	36 83.80 **Kr** Krypton [Ar] $3d^{10}4s^24p^6$
5	37 85.47 **Rb** Rubidium [Kr] $5s^1$	38 87.62 **Sr** Strontium [Kr] $5s^2$	39 88.91 **Y** Yttrium [Kr] $4d^15s^2$	40 91.22 **Zr** Zirconium [Kr] $4d^25s^2$	41 92.91 **Nb** Niobium [Kr] $4d^45s^1$	42 95.94 **Mo** Molybdenum [Kr] $4d^55s^1$	43 98 **Tc** Technetium [Kr] $4d^55s^2$	44 101.07 **Ru** Ruthenium [Kr] $4d^75s^1$	45 102.91 **Rh** Rhodium [Kr] $4d^85s^1$	46 106.42 **Pd** Palladium [Kr] $4d^{10}$	47 107.87 **Ag** Silver [Kr] $4d^{10}5s^1$	48 112.41 **Cd** Cadmium [Kr] $4d^{10}5s^2$	49 114.82 **In** Indium [Kr] $4d^{10}5s^25p^1$	50 118.71 **Sn** Tin [Kr] $4d^{10}5s^25p^2$	51 121.76 **Sb** Antimony [Kr] $4d^{10}5s^25p^3$	52 127.60 **Te** Tellurium [Kr] $4d^{10}5s^25p^4$	53 126.90 **I** Iodine [Kr] $4d^{10}5s^25p^5$	54 131.30 **Xe** Xenon [Kr] $4d^{10}5s^25p^6$
6	55 132.91 **Cs** Caesium [Xe] $6s^1$	56 137.33 **Ba** Barium [Xe] $6s^2$		72 178.49 **Hf** Hafnium [Xe] $4f^{14}5d^26s^2$	73 180.95 **Ta** Tantalum [Xe] $4f^{14}5d^36s^2$	74 183.84 **W** Tungsten [Xe] $4f^{14}5d^46s^2$	75 186.20 **Re** Rhenium [Xe] $4f^{14}5d^56s^2$	76 190.23 **Os** Osmium [Xe] $4f^{14}5d^66s^2$	77 192.22 **Ir** Iridium [Xe] $4f^{14}5d^76s^2$	78 195.08 **Pt** Platinum [Xe] $4f^{14}5d^96s^1$	79 196.97 **Au** Gold [Xe] $4f^{14}5d^{10}6s^1$	80 200.59 **Hg** Mercury [Xe] $4f^{14}5d^{10}6s^2$	81 204.38 **Tl** Thallium [Xe] $4f^{14}5d^{10}6s^26p^1$	82 207.2 **Pb** Lead [Xe] $4f^{14}5d^{10}6s^26p^2$	83 208.98 **Bi** Bismuth [Xe] $4f^{14}5d^{10}6s^26p^3$	84 209 **Po** Polonium [Xe] $4f^{14}5d^{10}6s^26p^4$	85 210 **At** Astatine [Xe] $4f^{14}5d^{10}6s^26p^5$	86 222 **Rn** Radon [Xe] $4f^{14}5d^{10}6s^26p^6$
7	87 223 **Fr** Francium [Rn] $7s^1$	88 226 **Ra** Radium [Rn] $7s^2$		104 261 **Rf** Rutherfordium [Rn] $5f^{14}6d^27s^2$	105 262 **Db** Dubnium [Rn] $5f^{14}6d^37s^2$	106 266 **Sg** Seaborgium [Rn] $5f^{14}6d^47s^2$	107 264 **Bh** Bohrium [Rn] $5f^{14}6d^57s^2$	108 277 **Hs** Hassium [Rn] $5f^{14}6d^67s^2$	109 268 **Mt** Meitnerium [Rn] $5f^{14}6d^77s^2$	110 281 **Ds** Darmstadtium [Rn] $5f^{14}6d^97s^1$	111 272 **Rg** Roentgenium [Rn] $5f^{14}6d^{10}7s^1$	112 285 **Cn** Copernicium [Rn] $5f^{14}6d^{10}7s^2$	113 286 **Nh** Nihonium [Rn] $5f^{14}6d^{10}7s^27p^1$	114 289 **Fl** Flerovium [Rn] $5f^{14}6d^{10}7s^27p^2$	115 290 **Mc** Moscovium [Rn] $5f^{14}6d^{10}7s^27p^3$	116 293 **Lv** Livermorium [Rn] $5f^{14}6d^{10}7s^27p^4$	117 294 **Ts** Tennessine [Rn] $5f^{14}6d^{10}7s^27p^5$	118 294 **Og** Oganesson [Rn] $5f^{14}6d^{10}7s^27p^6$

Lanthanides * $[4f^{1-14}5d^{0-1}6s^2]$	57 138.90 **La** Lanthanum [Xe] $5d^16s^2$	58 140.12 **Ce** Cerium [Xe] $4f^15d^16s^2$	59 140.91 **Pr** Praseodymium [Xe] $4f^36s^2$	60 144.24 **Nd** Neodymium [Xe] $4f^46s^2$	61 145 **Pm** Promethium [Xe] $4f^56s^2$	62 150.36 **Sm** Samarium [Xe] $4f^66s^2$	63 151.96 **Eu** Europium [Xe] $4f^76s^2$	64 157.25 **Gd** Gadolinium [Xe] $4f^75d^16s^2$	65 158.93 **Tb** Terbium [Xe] $4f^96s^2$	66 162.50 **Dy** Dysprosium [Xe] $4f^{10}6s^2$	67 164.93 **Ho** Holmium [Xe] $4f^{11}6s^2$	68 167.26 **Er** Erbium [Xe] $4f^{12}6s^2$	69 168.93 **Tm** Thulium [Xe] $4f^{13}6s^2$	70 173.04 **Yb** Ytterbium [Xe] $4f^{14}6s^2$	71 174.97 **Lu** Lutetium [Xe] $4f^{14}5d^16s^2$
Actinides * $[5f^{1-14}6d^{0-1}7s^2]$	89 227 **Ac** Actinium [Rn] $6d^17s^2$	90 232.04 **Th** Thorium [Rn] $6d^27s^2$	91 231.04 **Pa** Protactinium [Rn] $5f^26d^17s^2$	92 238.03 **U** Uranium [Rn] $5f^36d^17s^2$	93 237 **Np** Neptunium [Rn] $5f^46d^17s^2$	94 244 **Pu** Plutonium [Rn] $5f^67s^2$	95 243 **Am** Americium [Rn] $5f^77s^2$	96 247 **Cm** Curium [Rn] $5f^76d^17s^2$	97 247 **Bk** Berkelium [Rn] $5f^97s^2$	98 251 **Cf** Californium [Rn] $5f^{10}7s^2$	99 252 **Es** Einsteinium [Rn] $5f^{11}7s^2$	100 257 **Fm** Fermium [Rn] $5f^{12}7s^2$	101 258 **Md** Mendelevium [Rn] $5f^{13}7s^2$	102 259 **No** Nobelium [Rn] $5f^{14}7s^2$	103 262 **Lr** Lawrencium [Rn] $5f^{14}6d^17s^2$

Chapter 2 : Structure of Atom

Photoelectric Effect → $K.E. = h(\upsilon - \upsilon_0) = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$ → No. of electrons ejected ∝ Intensity of incident radiation → $K.E.$ of electrons ∝ Frequency of incident radiation → Each photon having energy equal to or greater than threshold energy can eject only one electron.

Towards Quantum Mechanical Model of the Atom

- **deBroglie Equation:** $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE_k}} = \frac{h}{\sqrt{2mqV}}$ where, E_k = kinetic energy, q = charge on particle, m = mass and V = accelerating potential.
- **Heisenberg's Uncertainty Principle :** $\Delta x \times \Delta p \geq \frac{h}{4\pi}$ or $\Delta x \times \Delta v \geq \frac{h}{4\pi m}$, where, Δx is uncertainty in position and Δp and Δv are uncertainty in momentum and velocity respectively.

Quantum Numbers

A set of four numbers which gives complete information about an electron in an atom.

Principal Quantum Number (*n*)

- **Values :** Any integer value *i.e.*, 1, 2, 3, 4, etc.
- **Information conveyed :** Main shell of the electron, approximate distance from the nucleus, energy of shell, maximum number of electrons present in the shell = $2n^2$ and explains the main lines of spectrum.

Azimuthal Quantum Number (*l*)

- **Values :** For a particular value of n, $l = 0$ to $n - 1$; $l = 0$, s-subshell; $l = 1$, p-subshell; $l = 2$, d-subshell; $l = 3$, f-subshell.
- **Information conveyed :** No. of subshells present in the main shell, relative energies of the subshells, shapes of orbitals and explains the fine structure of the line spectrum.

Magnetic Quantum Number (m_l)

- **Values :** For a particular value of l, $m = -l$ to $+l$ including zero.
- **Information conveyed :** No. of orbitals present in any subshell and explains the splitting of lines in a magnetic field.

Spin Quantum Number (m_s)

- **Values :** $+\frac{1}{2}$, $-\frac{1}{2}$
- **Information conveyed :** Direction of electron spin (clockwise or anticlockwise) and explains the magnetic properties of substances.
- For an atom of principal quantum number, n radial nodes = $(n - l - 1)$, angular nodes = l and total nodes = $(n - 1)$.
- In the ground state of the atoms, the orbitals are filled in order of their increasing energies. 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s........

Chapter 4 : Chemical Bonding and Molecular Structure

Spatial Arrangements of Different Hybridisation

No. of atomic orbitals	Hybridisation	Spatial Arrangement
2	sp	Linear
3	sp^2	Trigonal planar
4	sp^3	Tetrahedral
4	dsp^2	Square planar
5	sp^3d or dsp^3	Trigonal bipyramidal
6	sp^3d^2 or d^2sp^3	Octahedral
7	d^3sp^3 or sp^3d^3	Pentagonal bipyramidal

Molecular Orbital Theory

- Sequence of energy levels of molecular orbitals for Li_2, Be_2, B_2 and N_2 is $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < (\pi 2p_x = \pi 2p_y) < \sigma 2p_z < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$
- Sequence of energy levels of molecular orbitals for O_2 and F_2 is $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$
- Bond order = $\frac{1}{2}(N_b - N_a)$, [N_b = No. of bonding electrons, N_a = No. of anti-bonding electrons]
  If $N_b > N_a$; B.O. = +ve, molecule is stable.
  If $N_b < N_a$; B.O. = –ve, molecule is unstable.
  If $N_b = N_a$; B.O. = 0, molecule is unstable.

Chapter 5 : States of Matter (Gases and Liquids)

- **Boyle's law equation :** (At constant T and n)
  $V \propto 1/P$ or $PV = \text{constant}$ or $P_1V_1 = P_2V_2$
- **Charles' law equation :** (At constant P)
  $V \propto T$ or $V/T = \text{constant}$ or $V_1/T_1 = V_2/T_2$
- **Gay-Lussac's law :** (At constant V)
  $P \propto T$ or $P/T = \text{constant}$ or $P_1/T_1 = P_2/T_2$
- **Avogadro's law :** (Same condition of T and P)
  $V \propto n$ (number of moles of the gas)
- **Equation of state (Ideal gas) :** $PV = nRT$
- **Combined gas equation :** $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$
- **Density :** $d = PM/RT$
- **Compressibility factor :** $Z = PV_m/nRT$
- **van der Waals' equation of real gas :**
  $$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Chapter 6 : Thermodynamics

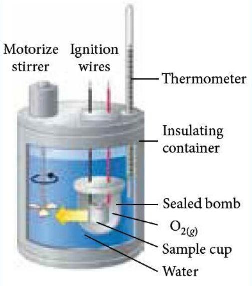
- Heat capacity at constant volume and at constant pressure are, $C_V = \left[\dfrac{\partial U}{\partial T}\right]_V$ and $C_P = \left[\dfrac{\partial H}{\partial T}\right]_P$
- Heat capacity, for an ideal gas, $C_P - C_V = R$ where, R is the gas constant.
- Work done in an isothermal reversible expansion,
  $$W_{\text{rev}} = -2.303\, nRT \log (V_2/V_1)$$
  $$W_{\text{rev}} = -2.303\, nRT \log (P_1/P_2)$$
- First law of thermodynamics : $\Delta U = q + W$
- The change in enthalpy, $\Delta H = \Delta U + p\Delta V$
  $= \Delta U + \Delta n_g RT$
  For exothermic reactions, ΔH is negative and for endothermic reactions, ΔH is positive.

Enthalpy of reaction

- $\Delta H = H_{(\text{products})} - H_{(\text{reactants})}$
- $\Delta H_{(\text{reaction})} = \Sigma B.E._{(\text{reactants})} - \Sigma B.E._{(\text{products})}$
- $\Delta H^\circ_{(\text{reaction})} = \Sigma \Delta H^\circ_{f(\text{products})} - \Sigma \Delta H^\circ_{f(\text{reactants})}$

Calculation of enthalpy change by using calorimeter :

$\Delta H = Q \times \Delta T \times M/m$, where, Q is the heat capacity of calorimeter system, ΔT is change in temperature, M is molecular mass of the substance and m is the amount of the substance.


Motorize stirrer
Ignition wires
Thermometer
Insulating container
Sealed bomb
$O_{2(g)}$
Sample cup
Water

Bomb calorimeter

Entropy

- It is the measure of degree of disorder or randomness of the system. $\Delta S = q_{\text{rev}}/T$
- For a spontaneous process, the entropy of universe must increase. *i.e.*, $\Delta S_{\text{uni}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}} > 0$

Condition for spontaneity

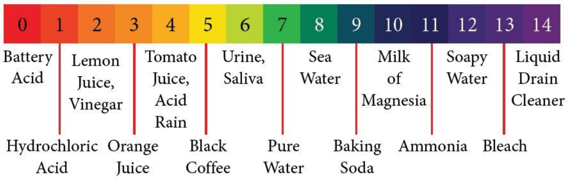
- If $\Delta H < 0, \Delta S > 0, \Delta G = -\text{ve} \Rightarrow$ always spontaneous.
- If $\Delta H > 0$, $\Delta S > 0$
  $\Rightarrow$ spontaneous at high temperature only.
- If $\Delta H < 0$, $\Delta S < 0$
  $\Rightarrow$ spontaneous at lower temperature only.

Chapter 7 : Equilibrium

- **Relationship between K_p and K_c :** $K_p = K_c(RT)^{\Delta n_g}$
  where, $\Delta n_g = n_p - n_r$ *i.e.*, no. of moles of gaseous products – no. of moles of gaseous reactants.
- **Ionic product of water :** $K_w = [H_3O^+][OH^-] = 10^{-14}$ (at 298 K), pH $= -\log[H_3O^+]$ or $[H_3O^+] = 10^{-\text{pH}}$,
  $p\text{OH} = -\log[OH^-]$, $pK_w = \text{pH} + \text{pOH} = 14$
  $pK_a = -\log K_a$, $pK_b = -\log K_b$
  $pK_a + pK_b = pK_w = 14$ (at 298 K) ; $K_a \cdot K_b = K_w$
- **Relation between solubility and solubility product :** If solubility of a sparingly soluble salt, A_xB_y is s mol/litre, then
  $$\underset{s\text{ moles}}{A_xB_y} \rightleftharpoons \underset{xs\text{ moles}}{xA^{y+}} + \underset{ys\text{ moles}}{yB^{x-}}$$
  Thus, $[A^{y+}] = xs$ and $[B^{x-}] = ys$
  $\therefore \quad K_{sp} = [A^{y+}]^x [B^{x-}]^y = (xs)^x (ys)^y$ or $x^x.y^y.s^{(x+y)}$
- **Criteria of precipitation of an electrolyte :**
  - $K_{ip} > K_{sp}$, solution is supersaturated and precipitation occurs.
  - $K_{ip} < K_{sp}$, solution is unsaturated and precipitation does not occur.
  - $K_{ip} = K_{sp}$, solution is saturated.

  where, K_{ip} = ionic product *i.e.*, product of conc. of ions present in solution.

The pH Scale

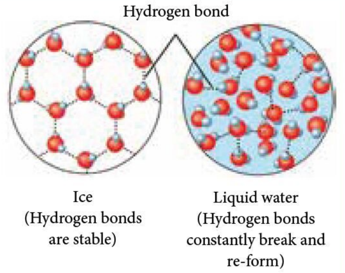

0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Battery Acid
Lemon Juice, Vinegar
Tomato Juice, Acid Rain
Urine, Saliva
Sea Water
Milk of Magnesia
Soapy Water
Liquid Drain Cleaner
Hydrochloric Acid
Orange Juice
Black Coffee
Pure Water
Baking Soda
Ammonia
Bleach

Chapter 8 : Redox Reactions

Terms	Oxidation	Reduction	Oxidising agent	Reducing agent
Change in oxidation number	Increase	Decrease	Decrease	Increase
Change in electrons	Loss of electrons	Gain of electrons	Accepts electrons	Donates electrons

Chapter 9 : Hydrogen

- **Strength of hydrogen peroxide :**
  - Percent strength = 17/56 × volume strength
  - Volume strength = 5.6 × normality
  - Volume strength = 11.2 × molarity
- **Hydrogen bonding :** In solid state (ice), water molecules are arranged in highly ordered three dimensional open cage like structure through hydrogen bonding, which results in lower density of ice than that of liquid water.



Chapter 10 : The *s* - Block Elements

Some general trends of alkali metals and their compounds :

Lithium is used to make batteries

- **Electropositive character :** $Li < Na < K < Rb < Cs$
- **Hydration enthalpy :** $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
- **Reducing character :** $Na < K < Rb < Cs < Li$
- **Solubility and basic character of hydroxides :** $LiOH < NaOH < KOH < RbOH < CsOH$
- **Stability of carbonates :** $Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$

Some general trends of alkaline earth metals and their compounds :

- **Hydration enthalpy :** $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$
- **Reducing character :** $Be < Mg < Ca < Sr < Ba < Ra$
- **Solubility, thermal stability and basic character of hydroxides :** $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$
- **Solubility of carbonates :** $BeCO_3 > MgCO_3 > CaCO_3 > \underbrace{SrCO_3 > BaCO_3}_{\text{Almost insoluble}}$

Chapter 11 : The *p* - Block Elements (Group 13 and 14)

- **Basic nature of oxides and hydroxides :** $B < Al < Ga < In < Tl$
- **Lewis acid character :** $BI_3 > BBr_3 > BCl_3 > BF_3$
- **Ionization enthalpies :** $B > Tl > Ga > Al > In$
- **Ionization enthalpies :** $C > Si > Ge > Pb > Sn$
- **Stability of tetrahalides :** $CX_4 > SiX_4 > GeX_4 > SnX_4 > PbX_4$

Buckminster fullerene (C_{60}) has a structure similar to the structure of the dome of Montreal Biosphere, Quebec, Canada

Uses of Silicon

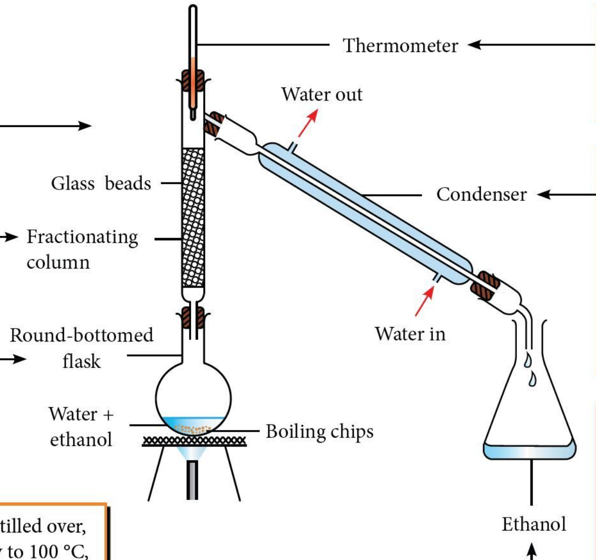
- In microprocessor
- In alloys
- As a fire-proof material : Ceramics
- In agriculture as fertilizers
- In lasers
- In medicines (breast implants and a contact lens)

Chapter 12 : Organic Chemistry – Some Basic Principles and Techniques

- **Inductive effect (*I* effect) :** Displacement of σ electrons along a saturated carbon chain when an electron donating (**+*I* effect**) or electron withdrawing (**–*I* effect**) group is attached at the end of the carbon chain.
- **Decreasing order of –*I* effect :** $-NO_2 > -SO_2R > -CN > -COOH > -F > -Cl > -Br > -I > -OH > -OR > -C_6H_5 > -CH{=}CH_2 > -H$
- **Decreasing order of +*I* effect :**
  $(CH_3)_3C- > (CH_3)_2CH- > CH_3CH_2- > CH_3- > D > H$
- **Relative stabilities of carbocations follow the order :**
  - $CH_3CH_2CH_2\overset{+}{C}H_2 > CH_3CH_2\overset{+}{C}H_2 > CH_3\overset{+}{C}H_2 > \overset{+}{C}H_3$
  - $Ph_3\overset{+}{C} > Ph_2\overset{+}{C}H > (CH_3)_3\overset{+}{C} > Ph\overset{+}{C}H_2 > (CH_3)_2\overset{+}{C}H > \overset{+}{C}H_3$
- **Relative stabilities of carbanions follow the order :** $(C_6H_5)_3\bar{C} > (C_6H_5)_2\bar{C}H > C_6H_5\bar{C}H_2 > CH_2{=}CH-\bar{C}H_2 > HC{\equiv}\bar{C} > H_2C{=}\bar{C}H > \bar{C}H_3 > \underset{1°}{CH_3\bar{C}H_2} > \underset{2°}{(CH_3)_2\bar{C}H} > \underset{3°}{(CH_3)_3\bar{C}}$
- **+*R* or +*M* effect :** $-OH$, $-OR$, $-OOCR$, $-NH_2$, $-NHR$, $-NR_2$, $-NHCOR$
- **–*R* or –*M* effect :** $-COOH$, $-CHO$, $>C{=}O$, $-CN$
- **+*E* effect :** When π-electrons of multiple bonds are transferred towards the atom to which the attacking reagent gets attached.
- **–*E* effect :** When π-electrons of multiple bonds are transferred away from the atom to which the attacking reagent gets attached.

Fractional Distillation

What happens when a solution of ethanol and water undergoes fractional distillation?



1 Ethanol vapour and water vapour rise up the column as the solution is heated.

2 The water vapour condenses in the fractionating column and drops back into the flask.

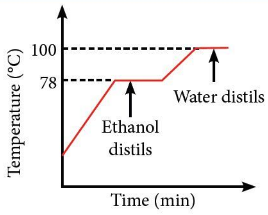
3 Ethanol, which has a lower boiling point than water, reaches the upper part of the column and is distilled over first.

4 At this stage, the thermometer shows a constant temperature of 78 °C, which is the boiling point of ethanol.

5 In the condenser :
- Hot ethanol vapour condenses as running water cools it.
- Liquid ethanol flows down the inner tube of the condenser and into the receiver (a conical flask).

6 Ethanol is collected as the distillate in the receiver.

7 When all the ethanol has distilled over, the temperature rises rapidly to 100 °C, which is the boiling point of water. At this temperature, water distils over and can be collected separately in another receiver.



Graph showing how temperature changes as an ethanol-water mixture is fractionally distilled.

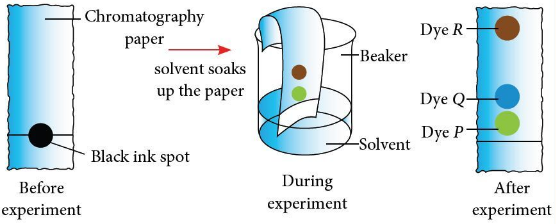
Fractional distillation of solution of water and ethanol

Chromatography

Retardation factor (R_f) values can be obtained from chromatograms. An R_f value is defined as the ratio of the distance travelled by the solute to the distance travelled by the solvent.

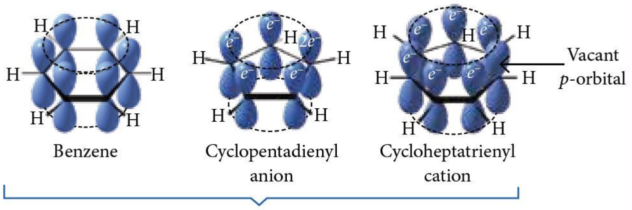
Separation of different components of black ink

The black ink separates into three dyes : *P*, *Q* and *R*.



Chapter 13 : Hydrocarbons

- According to **Markownikoff's rule**, during addition reactions, the negative part of the reagent goes to that carbon atom which has least number of hydrogen or more number of alkyl groups.
- In presence of peroxides, additon of HBr to unsymmetrical alkenes takes place contrary to Markownikoff's rule. This addition is anti to Markownikoff's rule. This process is known as **Kharasch effect.**
- **Huckel rule of aromaticity :** It is applied to all the ring systems whether they have benzene ring or not and possess the following characteristics :
  - Planarity
  - Complete delocalisation of π-electrons in the ring.
  - Presence of $(4n + 2)\pi$-electrons in the ring where, $n = 0, 1, 2, 3, \ldots$.



Benzene

Cyclopentadienyl anion

Cycloheptatrienyl cation

($n = 1$, 6 π electrons)

- *o*, *p*-directing groups activate benzene ring towards substitution whereas *m*-directing groups deactivate benzene ring.
- *Ortho* and *para* directing groups also called activating groups, direct the incoming group to *ortho* and *para* positions of benzene ring. For example, $—CH_3$, $—C_2H_5$, $—OCH_3$, $—NH_2$, $—NHR$, $—NHCOCH_3$, etc.
- Halogens are *o*- and *p*- directing groups but are moderately deactivating due to their strong $-I$ effect.
- *Meta* directing groups also called deactivating groups, direct the incoming group to *meta* position of benzene ring. For example, $—NO_2$, $—CN$, $—CHO$, $—COR$, $—COOH$, $—COOR$, $—SO_3H$, etc.

Chapter 14 : Environmental Chemistry

- Sulphur dioxide and particulate matter are main components of **classical smog** that occurs in cool humid climate. It is chemically reducing in nature.
- **Photochemical smog :** It is formed by the action of sunlight on unsaturated hydrocarbons and nitrogen oxides. They have high concentration of oxidising agents thus called oxidising smog. It occurs in warm, dry and sunny climate.
- **Biochemical Oxygen Demand (BOD) :** It is the amount of the dissolved oxygen that would be needed by the microorganisms to break down the organic matter present in a certain volume of the sample of water. For clean water it is < 5 ppm and for polluted water, it is > 17 ppm.

GK CORNER

Enhance Your General Knowledge with Current Updates!

SCHEMES AND APPOINTMENTS

- **Atmanirbhar Clean Plant Program :** It will be launched with an outlay of Rs. 2,200 crore to boost availability of disease-free, quality planting material for high value horticultural crops, the Union Minister for Finance and Corporate Affairs Smt. Nirmala Sitharaman said while presenting the Union Budget 2023-24.
- **Monument Mitra Scheme:** It was launched under 'Adopt A Heritage' project with the aim to ensure quality and inclusive provision of amenities and facilities across heritage, natural and tourist sites. Now, private and public sector organisations and individuals will be able to 'adopt' around 1,000 monuments with the help of the Archaeological Survey of India to develop, upgrade and maintain the facilities. These organisations or individuals would be known as "Monument Mitras" for their collaboration initiative.
- Hon'ble Mr. Justice Rajesh Bindal and Hon'ble Mr. Justice Aravind Kumar took oath on 13 February 2023. Supreme Court of India now has its full strength of 34.
- **MISHTI (Mangrove Initiative for Shoreline Habitats & Tangible Income):** It was announced in Union Budget 2023-24 to preserve Mangrove forests, prevent erosion and to stabilise coastline ecosystems by planting mangrove trees along the coastline and on salt pan lands. It will be implemented with CAMPA Fund, MGNREGS and other sources.
- **Yuva Sangam Portal:** A registration portal launched at IGNCA, New Delhi on 6 February 2023. It is an initiative of the Prime Minister to build close ties between the youth of North East Region and rest of India under the spirit of 'Ek Bharat Shreshtha Bharat'. Over the next few months, more than 20,000 students will travel across India and enhance their mutual understanding.
- The Institute of Chartered Accountants of India (ICAI) has elected Mr. Aniket Sunil Talati as its president for the term 2023-24. He is also appointed as the Board member of SAFA (South Asian Federation of Accountants).
- **Project Vaani:** A project launched by Indian Institute of Science (IISc) and ARTPARK (AI & Robotics Technology Park) and funded by Google with the idea 'Capturing The Language Landscape Of India For An Inclusive Digital India'. This will boost the development of technologies such as Automatic Speech Recognition (ASR), Speech to Speech Translation (SST) and Natural Language Understanding (NLU) that reflect the ground realities of how Indians speak.
- Mr. Ajay Kumar Srivastava has been appointed as the Managing Director (MD) and Chief Executive Officer (CEO) of the Indian Overseas Bank with

effect from 1 January 2023. He started his banking career as a Probationary Officer in 1991 with Allahabad Bank.

- Reserve Bank of India (RBI) approved the appointment of Mr. Surinder Chawla, a veteran banker, as the new Managing Director (MD) and Chief Executive Officer (CEO) of Paytm Payments Bank for a period of three years.
- **Green Hydrogen Blending:** This project is a joint venture of National Thermal Power Corporation (NTPC) and Gujarat Gas Limited (GGL) to supply H_2-NG (natural gas) to households of Kawas township at Adityanagar, Surat. Green hydrogen is made by electrolysis of water and reduces CO_2 emissions when blended with natural gas, keeping net heating content same.

Test Yourself!

1. Who is appointed as the new Chief Executive Officer (CEO) of Paytm Payments Bank?
(a) Vijay Shekhar Sharma
(b) Anubrata Biswas
(c) Surinder Chawla
(d) Kalyan Krishnamurthy

2. Which of the following statements is correct for Hindi Diwas?
(a) It marks the day when Hindi was first spoken in the United Nations' General Assembly in 1949.
(b) The very first World Hindi Day was celebrated on February 10, 2005.
(c) It was first celebrated in 2006 to commemorate the anniversary of the first World Hindi Conference which was held in Nagpur on 10th January, 1975.
(d) Both (a) and (b)

3. Which Indian state got the world's first Palm-leaf Manuscript Museum?
(a) Delhi (b) Kerala
(c) Karnataka (d) Tamil Nadu

4. Consider the following statements with respect to Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM KUSUM) Scheme.
I. It includes installation of small Solar Power Plants.
II. It aims to add solar and other renewable capacity of 25,750 MW by 2022.
III. It is being implemented through the ministry of power.
Which of the statements given above is/are correct?
(a) I and II only (b) I only
(c) I, II and III only (d) All of these

5. Which of the following has teamed up with the Indian Institute of Science (IISc) for Project Vaani?
(a) Google (b) Apple
(c) Facebook (d) Twitter

6. Who is the current Managing Director and CEO of Indian Overseas Bank?
(a) Ajay Kumar Srivastava
(b) Rajni Kakkar
(c) Manoj Singh
(d) Sandeep Bakhshi

7. With reference to black soil, consider the following statements:
I. It covers most of the Deccan Plateau which only includes parts of Maharashtra, Madhya Pradesh and Gujarat.
II. It is generally clayey, deep and impermeable.
III. It is rich in lime, iron, magnesia and phosphorus.
Which of the statements given above is/are correct?
(a) I and II only (b) II and III only
(c) II only (d) III only

SOLUTIONS TO FEBRUARY 2023 QUIZ CLUB

1. Amorphous
2. Transuranium
3. Mercury
4. Brownian movement
5. $CO + H_2$
6. Zone refining
7. Benzene
8. Nitric acid
9. +5
10. MnO_2
11. 6
12. Benzene Hexachloride (BHC)
13. 2, 4, 6-Trinitrophenol
14. Formalin
15. Graphite
16. Sugar
17. Quantum
18. Hydrogen
19. Balmer
20. 2

Winner : *Kaushikkumar Kevadiya*

8. Select the correct statement with respect to Genome India Project.
   (a) This project will help in the development of personalised medicine, anticipating diseases and modulating treatment according to the genome of patients.
   (b) It aims to ultimately build a grid of the Indian reference genome, to understand the genetic nature of only Indo-Aryan people in the Indian population.
   (c) It is being spearheaded by the IISc, Madras.
   (d) All are correct

9. The Budget 2023-24 announced an initiative 'MISHTI'. It is expanded as
   (a) Marine Planning and Innovation for Sustainable Tourism in India
   (b) Mangrove Initiative for Shoreline Habitats & Tangible Incomes
   (c) Management and Integration of Scheduled Tribe of India
   (d) Major Innovation in Small Tribal India

10. Food Safety and Standards Authority of India is a statutory body established under which Union Ministry?
   (a) Ministry of Health and Family Welfare
   (b) Ministry of Commerce and Industry
   (c) Ministry of Consumer Affairs
   (d) Ministry of Agriculture and Family Welfare

Answer Key

1. (c) **2.** (d) **3.** (b) **4.** (a) **5.** (a)
6. (a) **7.** (c) **8.** (a) **9.** (b) **10.** (a)

◆◆

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. IVOCSYITS	(a) The gas which is used to manufacture vanaspati ghee from vegetable oil.
2. MSMATRIMEE	(b) It is an acid found in tamarind, having IUPAC name 2,3-dihydroxybutanedioic acid.
3. RCTIATAR	(c) It is a type of the structural isomerism that arises due to the presence of different alkyl chains on either side of the functional group.
4. NGHDOYRE	(d) The elements that belong to Group 16 of the modern periodic table.
5. HALCOGSNEC	(e) The process in which nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and results in subsequent loss of biodiversity.
6. IHNIIBOTR	(f) It is the measure of resistance to flow due to internal friction between the layers of fluid.
7. LCAERROTYMI	(g) It is an experimental technique used to measure energy changes associated with chemical or physical processes.
8. URTECIOHPTANOI	(h) The distance between two consecutive crests or troughs of the light wave.
9. VENGHTWLAE	(i) The process that involves the separation of ion which occurs when a solid ionic compound dissolves.
10. OOSSIIIANDCT	(j) A general term used for any compound which will slow down or stop a reaction, generally by preventing propagation of chain reactions or by passivation of surfaces, etc.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

JEE WORK OUTS

SINGLE OPTION CORRECT TYPE

1. **Statement-1 :** 4*s* orbital has lower energy than 3*d* orbitals.
   Statement-2 : *s*-orbital is spherical, remains closer to nucleus and has lower energy than *d*-orbitals.
   (a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
   (b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
   (c) Statement-1 is true, statement-2 is false.
   (d) Statement-1 is false, statement-2 is true.

2. **Statement-1 :** The pressure of a fixed amount of an ideal gas is proportional to its temperature.
   Statement-2 : Frequency of collisions and their impact both increase in proportion to the square root of temperature.
   (a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
   (b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
   (c) Statement-1 is true, statement-2 is false.
   (d) Statement-1 is false, statement-2 is true.

3. **Statement 1 :** H_2O_2 can act as both oxidising and reducing agent in basic medium.
   Statement 2 : In the hydrogen economy, the energy is transmitted in the form of dihydrogen.
   In the light of the above statements, choose the correct answer from the options given below :
   (a) Statement 1 is false but statement 2 is true.
   (b) Statement 1 is true but statement 2 is false.
   (c) Both statement 1 and statement 2 are true.
   (d) Both statement 1 and statement 2 are false.

4. The type of hybrid orbitals used by the chlorine atom in ClO_2^- is
   (a) sp^3
   (b) sp^2
   (c) sp
   (d) none of these.

5. Standard electrode potential data are useful for understanding the suitability of an oxidant in a redox titration. Some half cell reactions and their standard potentials are given below :

$$MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}\ ; \quad E° = 1.51\ V$$

$$Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^- \rightarrow 2Cr^{3+}_{(aq)} + 7H_2O\ ; \quad E° = 1.38\ V$$

$$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}\ ; E° = 0.77\ V$$

$$Cl_{2(g)} + 2e^- \rightarrow 2Cl^-_{(aq)}\ ; E° = 1.40\ V$$

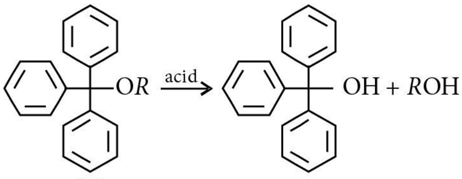
   Identify the only incorrect statement regarding the quantitative estimation of aqueous $Fe(NO_3)_2$.
   (a) MnO_4^- can be used in aqueous HCl.
   (b) $Cr_2O_7^{2-}$ can be used in aqueous HCl.
   (c) MnO_4^- can be used in aqueous H_2SO_4.
   (d) $Cr_2O_7^{2-}$ can be used in aqueous H_2SO_4.

6. Higher order (>3) reactions are rare due to
   (a) shifting of equilibrium towards reactants due to elastic collisions
   (b) loss of active species on collision
   (c) low probability of simultaneous collision of all the reacting species
   (d) increase in entropy and activation energy as more molecules are involved.

7. $[NiCl_2\{P(C_2H_5)_2(C_6H_5)\}_2]$ exhibits temperature dependent magnetic behaviour (paramagnetic/diamagnetic). The coordination geometries of Ni^{2+}

in the paramagnetic and diamagnetic states are respectively
(a) tetrahedral and tetrahedral
(b) square planar and square planar
(c) tetrahedral and square planar
(d) square planar and tetrahedral.

8. The acidic hydrolysis of ether (X) shown below is fastest when



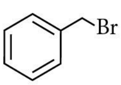
(X)

(a) one phenyl group is replaced by a methyl group
(b) one phenyl group is replaced by a *para*-methoxyphenyl group
(c) two phenyl groups are replaced by two *para*-methoxyphenyl groups
(d) no structural change is made to X.

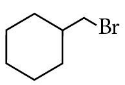
ONE OR MORE THAN ONE OPTION CORRECT TYPE

9. For the reaction: $PCl_{5(g)} \longrightarrow PCl_{3(g)} + Cl_{2(g)}$
The forward reaction at constant temperature is favoured by
(a) introducing chlorine gas at constant volume
(b) introducing an inert gas at constant pressure
(c) increasing the volume of the container
(d) introducing PCl_5 at constant volume.

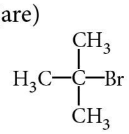
10. For the following compounds, the correct statement(s) with respect to nucleophilic substitution reactions is (are)



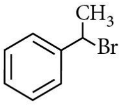
I



II



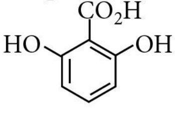
III



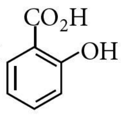
IV

(a) II follows S_N2 mechanism
(b) compound IV undergoes inversion of configuration
(c) the order of reactivity for I, III and IV is : IV > I > III
(d) I and III follow S_N1 mechanism.

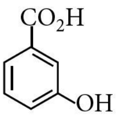
11. The correct order of acidity for the following compounds is



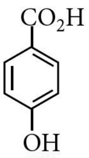
I



II



III



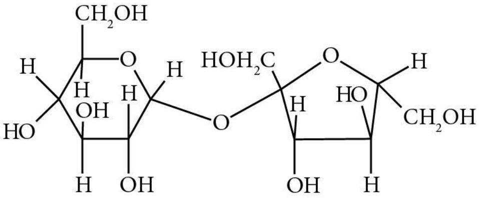
IV

(a) Acidity of I is greater than acidity of II.
(b) The correct order of acidity is II > I > IV > III.
(c) III is more acidic than II.
(d) IV is the most acidic while I is least acidic.

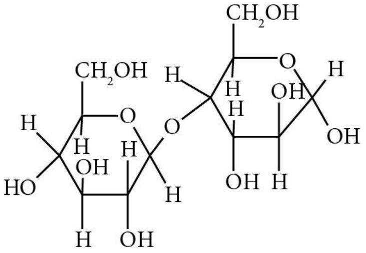
12. The product(s) not formed during the reaction of alcoholic silver nitrite with ethyl bromide is/are
(a) ethane
(b) ethene
(c) nitroethane
(d) ethyl alcohol.

13. The correct statement(s) about the following sugars X and Y is(are)

X=



Y=



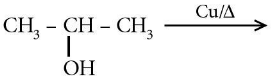
(a) X is a reducing sugar and Y is a non-reducing sugar
(b) X is a non-reducing sugar and Y is a reducing sugar
(c) the glycosidic linkages in X and Y are α and β respectively
(d) the glycosidic linkages in X and Y are β and α respectively.

14. Which of the following statements are true about the addition polymerisation?
(a) Addition polymerisation occurs between molecules containing double or triple bond.
(b) It takes place in the presence of organic peroxides.
(c) It proceeds via ionic mechanism in the presence of organic peroxides.
(d) Polythene and polystyrene are addition polymers.

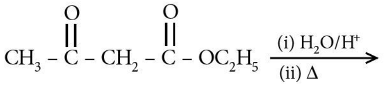
15. Which of the following reactions will give acetone?

(a) $CH_3-C\equiv N \xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } CH_3MgBr}$

(b)



$CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3 \xrightarrow{Cu/\Delta}$

(c) 

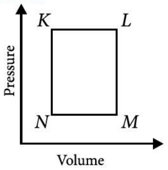
$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OC_2H_5 \xrightarrow[\text{(ii) }\Delta]{\text{(i) }H_2O/H^+}$

(d) $CH_3-COOH \xrightarrow{MnO/300^\circ C}$

PARAGRAPH BASED QUESTIONS

Paragraph for Q. No. 16 and 17

A fixed mass '*m*' of a gas is subjected to transformation of states from *K* to *L* to *M* to *N* and back to *K* as shown in the figure________.



16. The pair of isochoric processes among the transformation of states is
(a) *K* to *L* and *L* to *M* (b) *L* to *M* and *N* to *K*
(c) *L* to *M* and *M* to *N* (d) *M* to *N* and *N* to *K*

17. The succeeding operations that enable this transformation of states are
(a) heating, cooling, heating, cooling
(b) cooling, heating, cooling, heating
(c) heating, cooling, cooling, heating
(d) cooling, heating, heating, cooling.

Paragraph for Q. No. 18, 19 and 20

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles.

A solution *M* is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9.

Given : Freezing point depression constant of water ($K_{f\,\text{water}}$) = 1.86 K kg mol^{-1}
Freezing point depression constant of ethanol ($K_{f\,\text{ethanol}}$) = 2.0 K kg mol^{-1}
Boiling point elevation constant of water ($K_{b\,\text{water}}$) = 0.52 K kg mol^{-1}
Boiling point elevation constant of ethanol ($K_{b\,\text{ethanol}}$) = 1.2 K kg mol^{-1}
Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mmHg
Vapour pressure of pure ethanol = 40 mmHg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

18. The freezing point of the solution *M* is
(a) 268.7 K (b) 268.5 K
(c) 234.2 K (d) 150.9 K

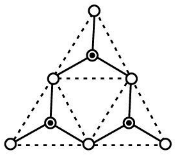
19. The vapour pressure of the solution *M* is
(a) 39.3 mmHg (b) 36.0 mmHg
(c) 29.5 mmHg (d) 28.8 mmHg

20. Water is added to the solution *M* such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is
(a) 380.4 K (b) 376.2 K
(c) 375.5 K (d) 354.7 K

NUMERICAL/INTEGER ANSWER TYPE

21. 29.2%(*w*/*w*) HCl stock solution has a density of 1.25 g mL^{-1}. The molecular weight of HCl is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is________.

22. The following structure is a silicate having formula $Si_3O_9^{x-}$. The value of *x* is________.



23. A first order reaction is 50% complete in 30 minutes at 27°C and in 10 minutes at 47°C. Calculate the energy of activation of the reaction in kJ/mol.

MATCHING LIST TYPE

24. Match the items in column I with its main uses listed in column II and select the correct option.

Column I		Column II	
(A)	Silica gel	(i)	Transistor
(B)	Silicon	(ii)	Ion-exchanger
(C)	Silicone	(iii)	Drying agent
(D)	Silicate	(iv)	Sealant

(a) (A) – (iii), (B) – (i), (C) – (iv), (D) – (ii)
(b) (A) – (iv), (B) – (i), (C) – (ii), (D) – (iii)
(c) (A) – (ii), (B) – (i), (C) – (iv), (D) – (iii)
(d) (A) – (ii), (B) – (iv), (C) – (i), (D) – (iii)

25. The unbalanced chemical reactions given in List I show missing reagent or condition (?) which are provided in List II. Match List I with List II and select the correct option.

	List I		**List II**
(A)	$PbO_2 + H_2SO_4 \xrightarrow{?} PbSO_4 + O_2$ + other product	(p)	NO
(B)	$Na_2S_2O_3 + H_2O \xrightarrow{?} NaHSO_4$ + other product	(q)	I_2
(C)	$N_2H_4 \xrightarrow{?} N_2$ + other product	(r)	Warm
(D)	$XeF_2 \xrightarrow{?} Xe$ + other product	(s)	Cl_2

	A	B	C	D
(a)	s	q	r	p
(b)	r	q	p	s
(c)	p	s	q	r
(d)	r	s	q	p

SOLUTIONS

1. (b)

2. (b): According to Gay - Lussac's law, at constant volume, the pressure of a given mass of a gas is directly proportional to the absolute temperature of the gas. $P \propto T$ or $P = kT$

3. (c) **4. (a)**

5. (a): The oxidation of Cl^- ion by MnO_4^- can be represented as

$$2MnO^-_{4(aq)} + 16H^+_{(aq)} + 10Cl^-_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 5Cl_{2(g)}$$

The cell corresponding to the above equation is

Pt, Cl_2 (1 atm)$|Cl^- || MnO_4^-, Mn^{2+}, H^+|Pt$

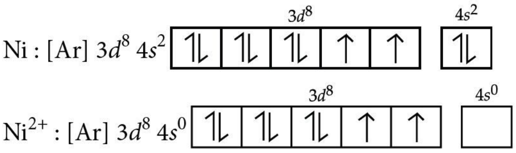
$E^\circ_{cell} = (1.51 - 1.40)\ V = 0.11\ V$

Since E°_{cell} is positive so ΔG° ($\Delta G^\circ = -nFE^\circ$) must be negative and so this cell is feasible.

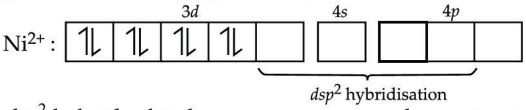
MnO_4^- will oxidise both Fe^{2+} ions and Cl^- ions simultaneously and so it cannot be used for the quantitative estimation of *aq*. $Fe(NO_3)_2$.

6. (c): The reactions of higher order are very rare because of the less chances of the molecules to come together simultaneously and collide.

7. (c): Electronic configuration of



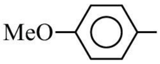
Paramagnetic behaviour is possible when pairing does not take place. *i.e.*, 3*d* will not participate in bonding and hybridisation will be sp^3 including 4*s* and 4*p*, thus structure is tetrahedral. When pairing takes places (in presence of strong ligand field),



dsp^2 hybrid orbitals arrange in square planar structure.

Ni^{2+} : paramagnetic, sp^3, tetrahedral

Ni^{2+} : diamagnetic, dsp^2, square planar

8. (c): Rate of S_N1 reaction is proportional to the stability of carbocation. When two phenyl groups are replaced by two  groups, the carbocation formed will be more stable. Hence, the reaction is fastest.

9. (b, c, d) : If we introduce an inert gas at constant pressure then the equilibrium is shifted in the direction in which the number of moles increases. In this case, the forward reaction is accelerated by increase in quantity of PCl_5 (a reactant) and also by increase of space (*i.e.*, volume of the container).

10. (a, b, d) : (a) Compound II is 1° alkyl halide, so it undergoes S_N2 mechanism.

(b) Compound IV undergoes inversion of configuration due to intimate-ion pair formation, inversion predominates over retention.

(c) Stability of carbocations follows the order :

2° benzylic > 3° alkyl > 1° benzylic
(IV) (III) (I)

(d) I is a benzylic halide, thus, it undergoes S_N1 reaction easily as benzylic carbocation is resonance stabilised. III also follows S_N1 mechanism as it a 3° alkyl halide.

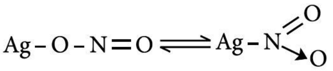
11. (a)

COMIC CAPSULE

I MAKE BAD CHEMISTRY JOKES BECAUSE ALL THE GOOD ONES "ARGON".

18
Ar
Argon
39.948

12. (a, b, d) : $AgNO_2$ (a salt of nitrous acid, HNO_2) occurs in two tautomeric forms.



$$Ag-O-N{=}O \rightleftharpoons Ag-N\overset{\nearrow O}{\underset{\searrow O}{}}$$

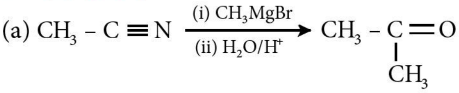
Thus NO_2^- ion from $AgNO_2$ may exist either as $^-O-N{=}O$ (nitrite ion, NO_2^-) forming alkyl nitrites or in $-N\overset{\nearrow O}{\underset{\searrow O}{}}$ (nitro group) forming nitroalkanes.

$$2C_2H_5Br + 2AgNO_2 \rightarrow \underset{\text{(Major product)}}{C_2H_5NO_2} + \underset{\text{(Minor product)}}{C_2H_5ONO} + 2AgBr$$

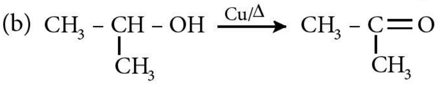
13. (b, c) : In sugar *X*, the reducing ends of both the sugars are not free whereas in sugar *Y*, reducing end at C-1 is free. So, *Y* is a reducing sugar.
The glycosidic linkage is α in *X* and β in *Y*.

14. (a, b, d) : Addition reactions (electrophilic or free radical) are common for the alkenes and alkynes which are initiated by ions or free radical initiators (R_2O_2).

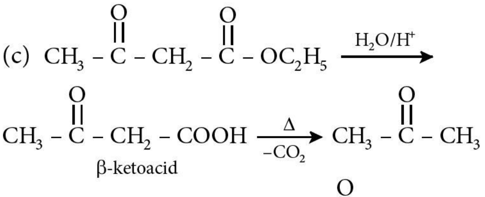
15. (a, b, c, d) :



$$\text{(a) } CH_3-C{\equiv}N \xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } CH_3MgBr} CH_3-\underset{\underset{CH_3}{|}}{C}{=}O$$

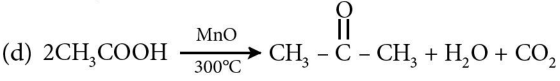


$$\text{(b) } CH_3-\underset{\underset{CH_3}{|}}{CH}-OH \xrightarrow{Cu/\Delta} CH_3-\underset{\underset{CH_3}{|}}{C}{=}O$$



$$\text{(c) } CH_3-\overset{\overset{O}{||}}{C}-CH_2-\overset{\overset{O}{||}}{C}-OC_2H_5 \xrightarrow{H_2O/H^+}$$

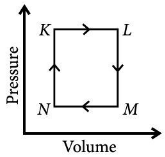
$$\underset{\beta\text{-ketoacid}}{CH_3-\overset{\overset{O}{||}}{C}-CH_2-COOH} \xrightarrow[-CO_2]{\Delta} CH_3-\overset{\overset{O}{||}}{C}-CH_3$$



$$\text{(d) } 2CH_3COOH \xrightarrow[300°C]{MnO} CH_3-\overset{\overset{O}{||}}{C}-CH_3 + H_2O + CO_2$$

16. (b): In isochoric process, volume is constant.

17. (c) : $K \rightarrow L$; heating, isobaric
$L \rightarrow M$; cooling, isochoric
$M \rightarrow N$; cooling, isobaric
$N \rightarrow K$; heating, isochoric



18. (d): $\Delta T_f = K_f \times m = 2 \times \dfrac{0.1}{0.9 \times 46} \times 1000$
or $\Delta T_f = 4.83$ K
Freezing point of solution *M*,
$T_f' = T_f^\circ - \Delta T_f = 155.7 - 4.83$
or $T_f' = 150.9$ K

19. (b): Total vapour pressure, $p = p_A^\circ x_A$
(Solute is non-volatile here.)
$p = 40 \times 0.9 = 36$ mm of Hg
(Vapour pressure of pure ethanol = 40 mm of Hg)

20. (b): $\Delta T_b = K_b \times m = 0.52 \times \dfrac{0.1}{0.9 \times 18} \times 1000$
or $\Delta T_b = \dfrac{520}{9 \times 18} = 3.20$
The boiling point of the solution,
$T_b' = T_b^\circ + \Delta T_b$; $T_b' = 373 + 3.20$
(Standard B.Pt. of water = 373 K)
$T_b' = 376.2$ K

21. (8): 29.2% *w*/*w* of HCl
Mass of HCl = 29.2 g,
Mass of solution = 100 g
$d = 1.25$ g/mL, $M_{HCl} = 36.5$ g mol^{-1}
Volume of solution = 100 g/1.25 g mL^{-1} = 80 mL

$$\text{Molarity} = \frac{(\text{g / M.W.})}{\text{Volume of solution}} \times 1000$$
$$= \frac{29.2 \times 1000}{36.5 \times 80} = 10 \text{ M}$$

Using $M_1V_1 = M_2V_2$
$10 \times V_1 = 200 \times 0.4 \Rightarrow V_1 = \dfrac{200 \times 0.4}{10} = 8$ mL

22. (6): $Si_3O_9^{6-}$

23. (43.85) : Since $t_{1/2} = \dfrac{0.693}{k}$, $\therefore k = \dfrac{0.693}{t_{1/2}}$
Given: $t_{1/2} = 30$ min at 27°C and $t_{1/2} = 10$ min at 47°C

$$\therefore k_{27} = \frac{0.693}{30} \text{ min}^{-1} = 0.0231 \text{ min}^{-1}$$
$$\text{and } k_{47} = \frac{0.693}{10} = 0.0693 \text{ min}^{-1}$$

We know that, $\log \dfrac{k_{47}}{k_{27}} = \dfrac{E_a}{2.303R} \times \dfrac{(T_2 - T_1)}{T_2 \times T_1}$

$$\therefore E_a = \frac{2.303R \times T_1 \times T_2}{(T_2 - T_1)} \log \frac{k_{47}}{k_{27}}$$
$$= \frac{2.303 \times 8.314 \times 10^{-3} \times 300 \times 320}{(320 - 300)} \log \frac{0.0693}{0.0231}$$

$= 43.848$ kJ mol$^{-1} \approx 43.85$ kJ mol^{-1}

24. (a): Silica gel absorbs moisture thus, acts as drying agent. Silicon being a semiconductor is used in transistors. Silicone is a sealant while silicates including zeolites act as ion-exchangers.

25. (d): a : $PbO_2 + H_2SO_4 \xrightarrow{\text{warm}} PbSO_4 + O_2 + H_2O$
b : $Na_2S_2O_3 + 5H_2O \xrightarrow{+4Cl_2} 2NaHSO_4 + 8HCl$
c : $N_2H_4 \xrightarrow{+2I_2} N_2 + 4HI$
b : $XeF_2 \xrightarrow{+2NO} Xe + 2NOF$

◆◆

CLASS-XI

BRUSH UP for NEET/JEE

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 7 Organic Chemistry : Some Basic Principles and Techniques

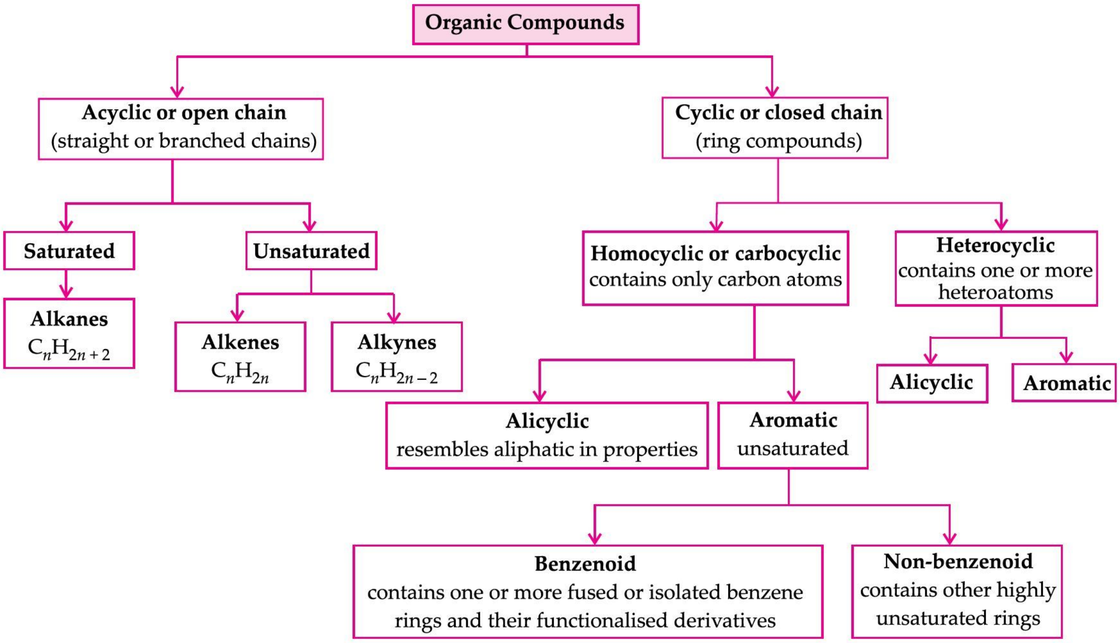
- **Organic chemistry** deals with the study of hydrocarbons (compounds of carbon and hydrogen) and other compounds regarded as derivatives of hydrocarbons. Some organic compounds may also contain nitrogen, oxygen, sulphur, phosphorus, halogens, etc.

Reasons for Existence of Large Number of Organic Compounds

- The existence of such a large number of organic compounds is due to the following properties of carbon:
  - **Catenation :** The property of atoms of an element to link with one another forming chains of identical atoms is called catenation. Carbon exhibits catenation to the maximum extent.
  - **Isomerism :** It is the property by virtue of which two or more compounds have the same molecular formula but different physical or chemical properties.
  - **Formation of multiple bonds :** Because of its small size, carbon atom is capable of forming multiple bonds with other atoms and this gives a variety of compounds.

CLASSIFICATION

Organic compounds are broadly classified into following categories depending upon the nature of their carbon skeleton.

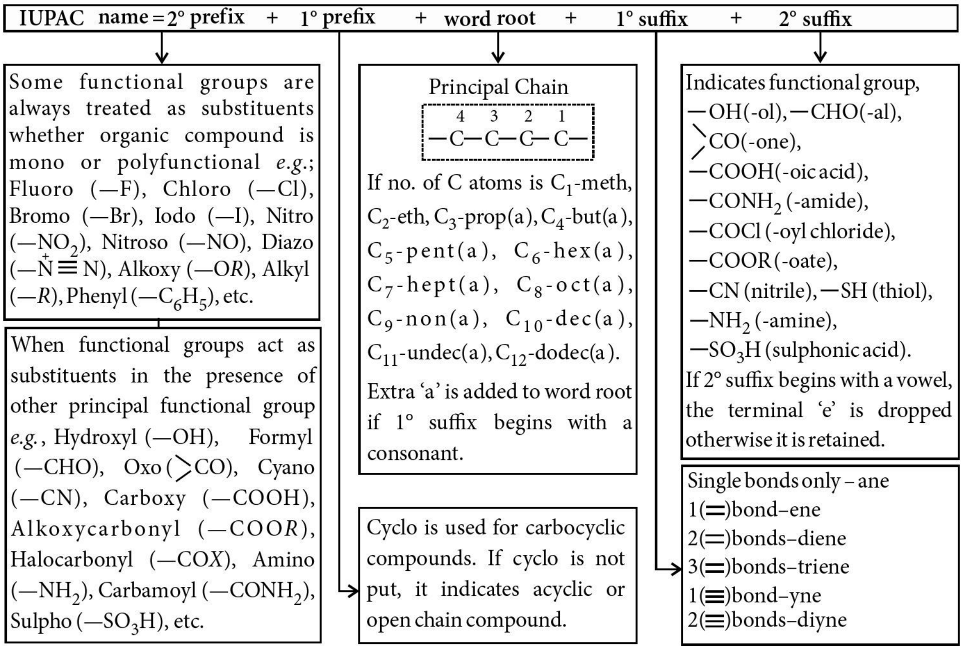

Organic Compounds
Acyclic or open chain
(straight or branched chains)
Cyclic or closed chain
(ring compounds)
Saturated
Unsaturated
Alkanes
C_nH_{2n+2}
Alkenes
C_nH_{2n}
Alkynes
C_nH_{2n-2}
Homocyclic or carbocyclic
contains only carbon atoms
Heterocyclic
contains one or more heteroatoms
Alicyclic
Aromatic
Alicyclic
resembles aliphatic in properties
Aromatic
unsaturated
Benzenoid
contains one or more fused or isolated benzene rings and their functionalised derivatives
Non-benzenoid
contains other highly unsaturated rings

Homologous Series

- A series of organic compounds each containing a characteristic functional group forms a homologous series in which each successive member differs by a $>CH_2$ group or by 12 + 2 × 1 = 14 mass unit. The members of the series are called **homologues** and the phenomenon is called **homology**.

NOMENCLATURE OF ORGANIC COMPOUNDS

- **IUPAC nomenclature :** The complete IUPAC name of an organic compound consists of five parts.



IUPAC name = 2° prefix + 1° prefix + word root + 1° suffix + 2° suffix

Some functional groups are always treated as substituents whether organic compound is mono or polyfunctional *e.g.*; Fluoro (—F), Chloro (—Cl), Bromo (—Br), Iodo (—I), Nitro ($—NO_2$), Nitroso (—NO), Diazo ($—\overset{+}{N}\equiv N$), Alkoxy (—O*R*), Alkyl (—*R*), Phenyl ($—C_6H_5$), etc.

When functional groups act as substituents in the presence of other principal functional group *e.g.*, Hydroxyl (—OH), Formyl (—CHO), Oxo ($>CO$), Cyano (—CN), Carboxy (—COOH), Alkoxycarbonyl (—COO*R*), Halocarbonyl (—CO*X*), Amino ($—NH_2$), Carbamoyl ($—CONH_2$), Sulpho ($—SO_3H$), etc.

Principal Chain

$$\overset{4}{C}—\overset{3}{C}—\overset{2}{C}—\overset{1}{C}$$

If no. of C atoms is C_1-meth, C_2-eth, C_3-prop(a), C_4-but(a), C_5-pent(a), C_6-hex(a), C_7-hept(a), C_8-oct(a), C_9-non(a), C_{10}-dec(a), C_{11}-undec(a), C_{12}-dodec(a).

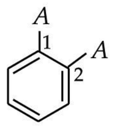
Extra 'a' is added to word root if 1° suffix begins with a consonant.

Cyclo is used for carbocyclic compounds. If cyclo is not put, it indicates acyclic or open chain compound.

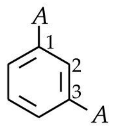
Indicates functional group, —OH(-ol), —CHO(-al), $>CO$(-one), —COOH(-oic acid), $—CONH_2$ (-amide), —COCl (-oyl chloride), —COOR (-oate), —CN (nitrile), —SH (thiol), $—NH_2$ (-amine), $—SO_3H$ (sulphonic acid). If 2° suffix begins with a vowel, the terminal 'e' is dropped otherwise it is retained.

Single bonds only – ane
1(=)bond–ene
2(=)bonds–diene
3(=)bonds–triene
1(≡)bond–yne
2(≡)bonds–diyne

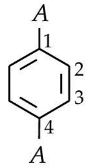
- Preference order for selection of a principal functional group in polyfunctional compounds is : —COOH, $—SO_3H$, —COO*R*, —COCl, $—CONH_2$, —CN, —CHO, $>C=O$, —OH, $—NH_2$, $>C=C<$, —C≡C—.
- For substituted benzene compounds, the substituent is placed as prefix to the word benzene.
- In disubstituted benzene ring, the substituents are given the lowest numbers possible while numbering the carbon atoms of the ring.
- In the trivial system of nomenclature, the prefix *ortho* (*o*-) indicates 1,2-, *meta* (*m*-) indicates 1,3- and *para* (*p*-) indicates 1,4-disubstituted benzene ring.



(1, 2-) *ortho*



(1, 3-) *meta*



(1, 4-) *para*

- In case of *tri-* or higher substituted benzene derivatives, common name of benzene derivatives is taken as the base compound. Number 1 position is assigned to the substituent of the base compound and lowest locant rule is followed for other substituents.
- Benzene ring is considered as substituent [Phenyl (Ph), $—C_6H_5$] when it is attached to an alkane with a functional group.

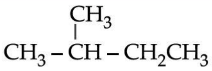
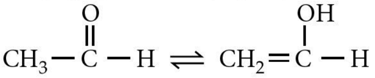
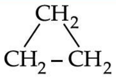
ISOMERISM

- Two or more compounds possessing same molecular formula but different physical and chemical properties are known as **isomers** and the phenomenon is called **isomerism**.

Structural Isomerism

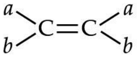
- Isomers with different structural formula.

Types of structural isomerism :

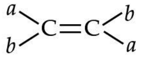
Name	Difference	Examples
Chain isomerism	in the arrangement of C-atoms constituting the chain.	$CH_3CH_2CH_2CH_2CH_3$,  $CH_3-\underset{}{\overset{CH_3}{\overset{\mid}{C}}}H-CH_2CH_3$ Pentane 2-Methylbutane
Position isomerism	in the position occupied by a particular atom or group in the same carbon chain.	$CH_3-CH_2-CH{=}CH_2$, $CH_3-CH{=}CH-CH_3$ 1–Butene 2–Butene
Functional group isomerism	in the nature of functional group present.	$C_2H_6O : CH_3CH_2OH$, CH_3-O-CH_3 Ethyl alcohol Dimethyl ether
Metamerism	in the alkyl chains on either side of the functional group.	$C_4H_{10}O : CH_3-O-CH_2CH_2CH_3$ Methyl propyl ether $CH_3-CH_2-O-CH_2-CH_3$ Diethyl ether
Tautomerism	in the position of H-atom linked to one polyvalent atom to the other within the same molecule, arising due to rearrangement of linkages. Tautomers exist in dynamic equilibrium with each other.	$H-C\equiv N \rightleftharpoons H-N\equiv C$ Hydrogen cyanide Hydrogen isocyanide  $CH_3-\overset{O}{\overset{\parallel}{C}}-H \rightleftharpoons CH_2{=}\overset{OH}{\overset{\mid}{C}}-H$ Acetaldehyde Vinyl alcohol
Ring-chain isomerism	in the bonding of carbon atom to form open chain and cyclic structure.	$CH_3-CH{=}CH_2$,  Propene Cyclopropane

Stereoisomerism

- Isomers which have the same structural formula but have different relative arrangement of atoms or groups in space are called **stereoisomers** and the phenomenon is called **stereoisomerism**.
- **Geometrical isomerism :** The compounds with same structural formula but different relative spatial arrangement of atoms or groups around the double bond are called **geometrical isomers** and the phenomenon is called **geometrical isomerism**. *e.g.*,



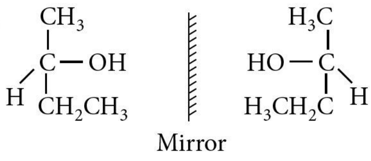
cis-isomer



trans-isomer

- **Optical isomerism :** Compounds which have same physical and chemical properties except their behaviour towards plane polarised light are called **optical isomers** and the phenomenon is called **optical isomerism**.

e.g.,



BOND FISSION OF A COVALENT BOND

The breaking of covalent bond can take place in two ways:

- **Homolytic Fission :** In this type of fission, each atom takes one electron and free radicals are formed.

  e.g., $\overset{\frown}{A}{-}\overset{\frown}{A} \xrightarrow[\text{or heat}]{\text{light}} \dot{A} + \dot{A}$
- **Heterolytic Fission :** In this type of fission, both the bonding electrons are attracted by more electronegative atom. *e.g.*, $A - \underset{\text{More electronegative}}{\overset{\curvearrowright}{B}} \longrightarrow \overset{+}{A} + \overset{-}{B}$

  Heterolytic fission results in formation of ions. If carbon possesses positive charge, it is known as **carbocation** and if carbon possesses negative charge, it is known as **carbanion**.

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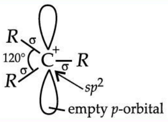
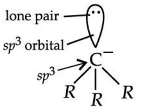
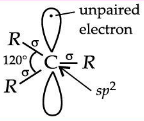
Reaction Intermediates

	Name	Structure	Stability
1.	Carbocations or carbonium ions (planar)	 R σ 120° σ C + σ R R sp² empty p-orbital	$(CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3\overset{+}{C}H_2 > \overset{+}{C}H_3$
2.	Carbanions (pyramidal)		$\overset{-}{C}H_3 > CH_3\overset{-}{C}H_2 > (CH_3)_2\overset{-}{C}H > (CH_3)_3\overset{-}{C}$
3.	Free radicals (planar, paramagnetic)	 unpaired electron R σ 120° σ C σ R R sp²	$(CH_3)_3\dot{C} > (CH_3)_2\dot{C}H > CH_3\dot{C}H_2 > \dot{C}H_3$

TYPES OF ATTACKING REAGENTS

- **Electrophiles (Lewis acids) :** They are electron deficient and accept electron pairs.

  Neutral : SO_3, $BeCl_2$, BF_3, $>C=O$, $:CCl_2$ (carbene)

  Charged : H^+, X^+, H_3O^+, NO_2^+, NO^+, CH_3^+

- **Nucleophiles (Lewis bases) :** They are electron rich and donate electrons.

  Neutral : $\ddot{N}H_3$, $H_2\ddot{\underset{..}{O}}$, $R\ddot{N}H_2$, $R\ddot{\underset{..}{O}}H$, $R\ddot{\underset{..}{O}}R$, $H_2\ddot{\underset{..}{S}}$

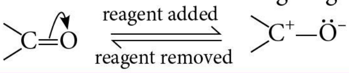
  Charged : $\bar{N}H_2$, $C\bar{N}$, $R\bar{N}H$, $R_2\bar{N}$, $RCO\bar{O}$

- **Ambiphiles (Amphoteric) :** They behave both as nucleophile and electrophile.

  Neutral : $R\ddot{\underset{..}{O}}H$, HOH, CH_3CN

  Charged : H_3O^+

ELECTRON DISPLACEMENT EFFECTS IN COVALENT BONDS

Inductive effect : Displacement of σ-electrons along a saturated carbon chain when an electron donating (+*I* effect) or electron withdrawing (–*I* effect) group is attached at the end of the carbon chain.	• **–*I* effect :** $R_3\overset{+}{N}—$, $—NO_2$, $—SO_2R$, $—CN$, $—COOH$, $—F$, $—Cl$, $—Br$, $—I$, $—OR$, $—COR$, $—OH$, $—C_6H_5$, $—CH=CH_2$, etc. • **+*I* effect :** $(CH_3)_3C—$, $(CH_3)_2CH—$, $CH_3CH_2—$, $CH_3—$, etc.
Electromeric effect : It involves complete transfer of π-electrons of a multiple bond towards one of the bonded atoms in the presence of an attacking reagent.	• **+*E* effect :** When electron transfer takes place towards the atom to which the attacking reagent gets attached. • **–*E* effect :** When electron transfer takes place away from the atom to which the attacking reagent gets attached.  $>C=O \underset{\text{reagent removed}}{\overset{\text{reagent added}}{\rightleftharpoons}} >C^+—\ddot{O}^-$
Resonance or mesomeric effect : It is defined as the polarity produced in the molecule by the interaction of two π-bonds or between a π-bond and a lone pair of electrons present on adjacent atom.	• **+*R* or +*M* effect :** $—Cl$, $—Br$, $—I$, $—NH_2$, $—NHR$, $—NR_2$, $—NHCOR$, $—OH$, $—OR$, $—SR$, $—SH$, $—OCH_3$, $—OCOR$, etc. • **–*R* or –*M* effect :** $—NO_2$, $—CN$, $—CHO$, $—COOH$, $—COR$, etc.
Hyperconjugation effect : It involves delocalisation of σ-electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom having vacant *p*-orbital.	• For an alkyl group attached to unsaturated system, it decreases with decrease in number of α-hydrogens : $CH_3— > CH_3CH_2— > (CH_3)_2CH— > (CH_3)_3C—$

TYPES OF ORGANIC REACTIONS

Substitution or Displacement Reactions

- In these reactions, an atom attached to a carbon atom in a molecule is replaced by another atom or group.

$$CH_4 + Cl_2 \xrightarrow{\text{UV light}} CH_3Cl + HCl$$

- Types of substitution or displacement reactions:
  - Free radical substitution
  - Electrophilic substitution
  - Nucleophilic substitution

Addition Reactions

- In these reactions, attacking reagent adds up to the substrate.

$$CH_2{=}CH_2 \xrightarrow[H_2/Ni]{200^\circ C} CH_3{-}CH_3$$

- These are also of three types :
  - Free radical addition
  - Electrophilic addition
  - Nucleophilic addition

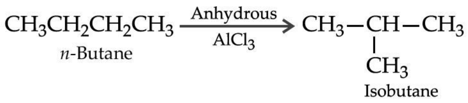
Elimination Reactions

- In these reactions, two atoms or groups are removed from a compound. It is the reverse of addition reaction.

$$H_3C-CH_2Br + \underset{\text{(Alc.)}}{KOH} \xrightarrow{-HBr} CH_2{=}CH_2 + KBr + H_2O$$

Rearrangement Reactions

- In these reactions, migration of an atom or a group from one site to another within the molecule takes place.



$$\underset{n\text{-Butane}}{CH_3CH_2CH_2CH_3} \xrightarrow[AlCl_3]{\text{Anhydrous}} \underset{\text{Isobutane}}{CH_3-\underset{CH_3}{\underset{|}{C}H}-CH_3}$$

METHODS OF PURIFICATION OF ORGANIC COMPOUNDS

- Organic compounds derived from natural sources or prepared in the laboratory are generally impure and need to be purified.
- Various methods are applied for purification which depend on the nature of the compounds and impurities mixed with them.

Method	Principle	Applications
Crystallisation	Different solubilities of a given organic compound and its impurities in the same solvent.	● Crystallisation of sugar (containing an impurity of common salt) is achieved by shaking the impure solid with hot ethanol at 348 K (sugar dissolves whereas common salt remains insoluble).
Sublimation	Some solid substances change from solid state to vapour state without passing through liquid state. Sublimable compounds get separated from non-sublimable impurities.	● Iodine from sodium chloride (as iodine sublimes readily leaving behind sodium chloride). ● Camphor, naphthalene, anthracene, benzoic acid, etc. are purified.
Simple distillation	It is used to separate ● volatile liquids from non-volatile impurities. ● liquids having sufficient difference in their boiling points.	● Hexane (b.p. 342 K) and toluene (b.p. 384 K) ● Chloroform (b.p. 334 K) and aniline (b.p. 457 K)
Fractional distillation	Used for separating liquids having boiling points close to each other. Vapours of less volatile liquid are condensed first.	● Crude oil in petroleum industry is separated into various useful fractions such as gasoline, kerosene oil, diesel oil, lubricating oil, etc.
Steam distillation	This method is used to separate substances which are steam volatile, immiscible with water, possess a vapour pressure of 10 – 15 mmHg and contain non-volatile impurities.	● Aniline is separated from aniline-water mixture. ● Essential oils, turpentine oil, nitrophenol, nitrobenzene, etc. can be purified.

Differential extraction	By shaking an aqueous solution of an organic compound with an organic solvent in which the organic compound is more soluble than in water. The organic solvent and the aqueous solution should be immiscible with each other so that they can form two distinct layers which can be separated by using separating funnel.	● Benzoic acid can be extracted from its water solution using benzene. ● Vanilla can be extracted from vanilla beans by soxhlet extractor.
Chromatography	Differential movement of individual components of a mixture through a stationary phase under the influence of a mobile phase.	● Widely used for separation, purification, identification and characterisation of the components of a mixture, whether coloured or colourless.
Adsorption chromatography	Differential adsorption of the various components of a mixture on a suitable adsorbent such as silica gel or alumina.	
Partition chromatography	Differential partitioning of components of a mixture between stationary and mobile phases.	● For separation of sugars and amino acids.

QUALITATIVE ANALYSIS OF ORGANIC COMPOUNDS

Element	Detection	Confirmatory test	Reactions
Carbon	Copper(II) oxide test $2CuO + C \xrightarrow{\Delta} 2Cu + CO_2\uparrow$	CO_2 gas turns lime water milky.	$CO_2 + \underset{\text{Lime water}}{Ca(OH)_2} \longrightarrow \underset{\text{(Milkiness)}}{CaCO_3\downarrow} + H_2O$
Hydrogen	$CuO + 2H \xrightarrow{\Delta} Cu + H_2O$	Water droplets appear on the cooler part of the ignition tube and also turns anhydrous $CuSO_4$ into blue.	$\underset{\text{(White)}}{CuSO_4} + 5H_2O \longrightarrow \underset{\text{(Blue)}}{CuSO_4.5H_2O}$
Nitrogen	Lassaigne's extract (L.E.) $Na + C + N \xrightarrow{\Delta} \underset{\text{(L.E.)}}{NaCN}$	L.E. + $FeSO_4$ (boil) + conc. H_2SO_4 Gives blue colour.	$6CN^- + Fe^{2+} \longrightarrow [Fe(CN)_6]^{4-}$ $3[Fe(CN)_6]^{4-} + 4Fe^{3+} \xrightarrow{xH_2O} \underset{\text{(Prussian blue)}}{Fe_4[Fe(CN)_6]_3.xH_2O}$
Sulphur	$2Na + S \xrightarrow{\Delta} \underset{\text{(L.E.)}}{Na_2S}$	● L.E. + sodium nitroprusside Gives a deep violet colour. ● L.E. + CH_3COOH + $(CH_3COO)_2Pb$ Gives a black ppt.	$Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5NO]} \longrightarrow \underset{\text{(Deep violet)}}{Na_4[Fe(CN)_5NOS]}$ $Na_2S + (CH_3COO)_2Pb \xrightarrow{CH_3COOH} \underset{\text{(Black ppt.)}}{PbS\downarrow} + 2CH_3COONa$
Halogens	$Na + X \xrightarrow{\Delta} \underset{\text{(L.E.)}}{NaX}$	L.E. + HNO_3 + $AgNO_3$ ● White ppt. soluble in *aq.* NH_3 (or NH_4OH) confirms Cl. ● Yellow ppt. partially soluble in *aq.* NH_3 (or NH_4OH) confirms Br. ● Yellow ppt. insoluble in *aq.* NH_3 (or NH_4OH) confirms I.	$NaX + AgNO_3 \xrightarrow{HNO_3} \underset{\text{(ppt.)}}{AgX\downarrow}$ $\underset{\text{(White ppt.)}}{AgCl} + 2NH_{3(aq)} \longrightarrow \underset{\text{(Soluble)}}{[Ag(NH_3)_2]Cl}$

Nitrogen and Sulphur	$Na + C + N + S \xrightarrow{\Delta} \underset{\text{(L.E.)}}{\underset{\text{thiocyanate}}{\underset{\text{Sodium}}{NaSCN}}}$	As in test for nitrogen; instead of green or blue colour, blood red colouration confirms presence of N and S both.	$NaSCN + FeCl_3 \longrightarrow \underset{\text{(Blood red colour)}}{[Fe(SCN)]Cl_2}$ $+ NaCl$
Phosphorus	$P \xrightarrow[\Delta]{Na_2O_2,\text{ boil}} Na_3PO_4$	Solution is boiled with nitric acid and then treated with ammonium molybdate $(NH_4)_2MoO_4$. Formation of yellow ppt. indicates presence of phosphate (hence, phosphorus) in organic compound.	$Na_3PO_4 + 3HNO_3 \longrightarrow H_3PO_4 + 3NaNO_3$ $H_3PO_4 + \underset{\text{Ammonium molybdate}}{12(NH_4)_2MoO_4} + 21HNO_3$ $\longrightarrow \underset{\text{(yellow ppt.)}}{\underset{\text{Ammonium phosphomolybdate}}{(NH_4)_3PO_4.12MoO_3}}$ $+ 21NH_4NO_3 + 12H_2O$

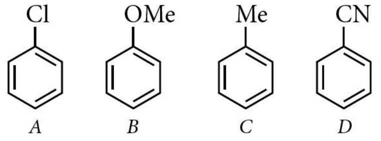
QUANTITATIVE ANALYSIS OF ORGANIC COMPOUNDS

Element	Method
Carbon and Hydrogen	**Liebig's combustion method :** $\% \text{ of C} = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of compound taken}} \times 100$; $\% \text{ of H} = \frac{2}{18} \times \frac{\text{mass of } H_2O \text{ formed}}{\text{mass of compound taken}} \times 100$
Nitrogen	**Dumas method :** $\% \text{ of N} = \frac{28}{22400} \times \frac{\text{vol. of } N_2 \text{ at STP}}{\text{mass of compound taken}} \times 100$ **Kjeldahl's method :** $\% \text{ of N} = \frac{1.4 \times \text{molarity of acid} \times \text{vol. of acid used} \times \text{basicity of acid}}{\text{mass of compound taken}}$
Halogens	**Carius method :** $\% \text{ of } X = \frac{\text{At. mass of } X}{(108 + \text{At. mass of } X)} \times \frac{\text{mass of Ag}X \text{ formed}}{\text{mass of compound taken}} \times 100$
Sulphur	**Carius method :** $\% \text{ of S} = \frac{32}{233} \times \frac{\text{mass of } BaSO_4 \text{ formed}}{\text{mass of compound taken}} \times 100$
Phosphorus	**Ignition method :** $\% \text{ of P} = \frac{62}{222} \times \frac{\text{mass of } Mg_2P_2O_7 \text{ formed}}{\text{mass of compound taken}} \times 100$
Oxygen	**Iodine method :** $\% \text{ of O} = \frac{32}{88} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of compound taken}} \times 100$

WRAP it up!

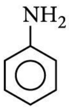
MCQs TYPE QUESTIONS

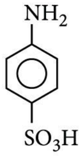
1. The increasing order of reactivity of the following compounds towards aromatic electrophilic substitution reaction is

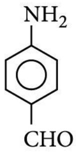


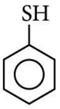
(a) $D < B < A < C$ (b) $B < C < A < D$
(c) $A < B < C < D$ (d) $D < A < C < B$

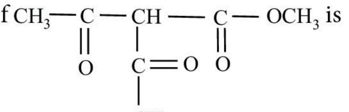
2. In Lassaigne's test, which of the following organic compounds will produce a blood red colour when its sodium extract is treated with $FeCl_3$ solution?

(a) 

(b) 

(c) 

(d) 

3. IUPAC name of  $CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{\underset{CH_3}{|}}{C=O}}{\underset{|}{CH}}-\underset{\underset{O}{\|}}{C}-OCH_3$ is

(a) Methyl-2,2-acetylethanoate
(b) 2,2-acetyl-1-methoxyethanone
(c) Methyl-2-acetyl-3-oxobutanoate
(d) none of the above.

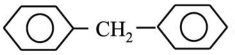
4. Basic strength of

$$\underset{(i)}{H_3C-\bar{C}H_2},\ \underset{(ii)}{H_2C=\bar{C}H} \text{ and } \underset{(iii)}{H-C\equiv\bar{C}}$$

is in the order of

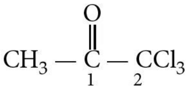
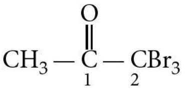
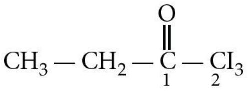
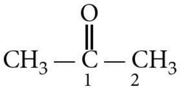
(a) (i) > (iii) > (ii) (b) (i) > (ii) > (iii)
(c) (ii) > (i) > (iii) (d) (iii) > (ii) > (i)

5. Steam distillation is based on the fact that vaporisation of organic liquids takes place at
(a) lower temperature than its boiling point
(b) higher temperature than its boiling point
(c) its boiling point
(d) water and organic liquid both undergo distillation.

6. The molecular formula of diphenylmethane,  is $C_{13}H_{12}$.

How many structural isomers are possible when one of the hydrogen is replaced by a chlorine atom?
(a) 6 (b) 4 (c) 8 (d) 7

7. Which of the following compounds yields most stable carbanion after rupture of ($C_1 - C_2$) bond?

(a)  $CH_3-\overset{\overset{O}{\|}}{\underset{1}{C}}-\underset{2}{C}Cl_3$
(b)  $CH_3-\overset{\overset{O}{\|}}{\underset{1}{C}}-\underset{2}{C}Br_3$
(c)  $CH_3-CH_2-\overset{\overset{O}{\|}}{\underset{1}{C}}-\underset{2}{C}I_3$
(d)  $CH_3-\overset{\overset{O}{\|}}{\underset{1}{C}}-\underset{2}{C}H_3$

8. Which of the following contains only electrophiles?
(a) $NH_2^-, NO_2^+, H_2O, NH_3$
(b) F^-, OH^-, NH_3, SO_3
(c) $NO_2^+, AlCl_3, SO_3, CH_3\overset{+}{C}=O$
(d) $NH_3, BF_3, AlCl_3, H_2O$

9. 0.58 g of hydrocarbon on combustion gave 0.9 g water. The percentage of carbon is about
(a) 75.8 (b) 82.7 (c) 27.85 (d) 68.8

10. Which of the following is a false statement?
(a) Kjeldahl's method is used for the estimation of nitrogen in an organic compound.
(b) Phosphoric acid produced on oxidation of phosphorus present in an organic compound is precipitated as $Mg_2P_2O_7$ by adding magnesia mixture.
(c) Carius method is used in the estimation of sulphur in an organic compound.
(d) Carius method is used for the estimation of nitrogen in an organic compound.

11. Geometry of methyl free radical is
(a) pyramidal (b) planar
(c) tetrahedral (d) linear.

12. Few mixtures and their methods of separation are given in the columns I and II respectively. Match the columns and mark the appropriate choice.

Column I		Column II	
(A)	Ether + Toluene	(i)	Steam distillation
(B)	*o*-Nitrophenol + *p*-Nitrophenol	(ii)	Distillation
(C)	Benzoic acid + Benzaldehyde	(iii)	Fractional distillation
(D)	Fractions of crude oil	(iv)	Sublimation

(a) (A) → (iii), (B) → (ii), (C) → (i), (D) → (iv)
(b) (A) → (ii), (B) → (iii), (C) → (i), (D) → (iv)
(c) (A) → (ii), (B) → (i), (C) → (iv), (D) → (iii)
(d) (A) → (i), (B) → (iii), (C) → (ii), (D) → (iv)

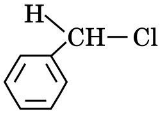
13. Which among the following compounds behaves both as an electrophile as well as a nucleophile?

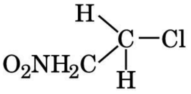
(1) NH_3
(2) $RCOCl$
(3) CH_3OCH_3
(4) RCN
(a) Only 1
(b) 2 and 4
(c) 3 and 4
(d) 2, 3 and 4

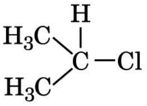
14. Kjeldahl's method cannot be used for the estimation of nitrogen in

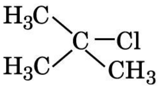
(a) pyridine
(b) nitro compounds
(c) azo compounds
(d) all of these.

15. In which of the following compounds, the C—Cl bond ionisation shall give the most stable carbonium ion?

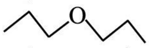
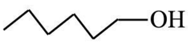
(a) 

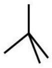
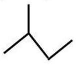
(b) 

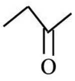
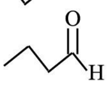
(c) 

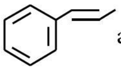
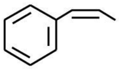
(d) 

16. Which of the following pairs of compounds does not represent structural isomers?

(a)  and 

(b)  and 

(c)  and 

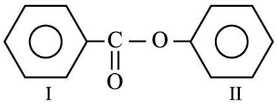
(d)  and 

17. In Kjeldahl's method of estimation of nitrogen, nitrogen is quantitatively converted in ammonium sulphate. It is then treated with standard solution of alkali. The nitrogen which is present in estimated as

(a) N_2 gas
(b) NO_2 gas
(c) NH_3 gas
(d) $(NH_4)_2SO_4$ ppt.

18. Lassaigne's test for the detection of nitrogen fails in

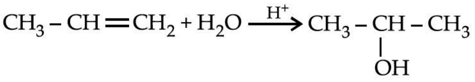
(a) $NH_2CONHNH_2{\cdot}HCl$
(b) $NH_2NH_2{\cdot}HCl$
(c) NH_2CONH_2
(d) $C_6H_5NHNH_2{\cdot}HCl$

19. In 

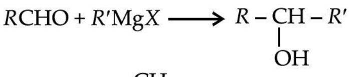
electrophilic substitution occurs at

(a) *ortho*/*para* at I ring
(b) *meta* at I ring
(c) *ortho*/*para* at II ring
(d) *meta* at II ring.

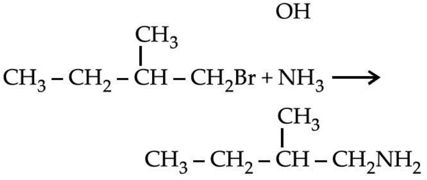
20. Which one is a nucleophilic substitution reaction among the following?

(a) 

$$CH_3-CH{=}CH_2+H_2O \xrightarrow{H^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$$

(b) 

$$RCHO+R'MgX \longrightarrow R-\underset{\displaystyle OH}{\underset{|}{CH}}-R'$$

(c) 

$$CH_3-CH_2-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2Br+NH_3 \longrightarrow CH_3-CH_2-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2NH_2$$

(d) $CH_3CHO + HCN \longrightarrow CH_3CH(OH)CN$

NUMERICAL VALUE TYPE QUESTIONS

21. The transformation occurring in Dumas method is given below.

$$C_2H_7N+\left(2x+\frac{y}{2}\right)CuO \rightarrow xCO_2+\frac{y}{2}H_2O+\frac{1}{2}N_2+\left(2x+\frac{y}{2}\right)Cu$$

The value of y is ________. (Integer answer)

22. In Carius method for estimation of halogens, 0.2 g of an organic compound gave 0.188 g of AgBr. The percentage of bromine in the compound is ______.

(Nearest integer)

[Atomic mass : Ag = 108, Br = 80]

23. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1 N HCl solution. The excess of the acid required 15 mL of 0.1 N NaOH solution for complete neutralization. The percentage of nitrogen in the compound is _______.

24. If 0.2 g of an organic compound containing carbon, hydrogen and oxygen on combustion yielded 0.147 g CO_2 and 0.12 g water. What will be the percentage of oxygen in substance?

25. The total number of acyclic structural isomers possible for compound with molecular formula $C_4H_{10}O$ is ________.

SOLUTIONS

1. **(d):** *o*, *p*-directing groups facilitate electrophilic aromatic substitution reaction and higher the electron donating ability of the substituent, faster is the reaction. The increasing order of reactivity is

$$\underset{(-I,\,-R)}{(D)} < \underset{(-I,\,+R)}{(A)} < \underset{(+I)}{(C)} < \underset{(+R)}{(B)}$$

2. **(b):** Organic compounds containing both N and S atoms give this test.

3. **(c)**

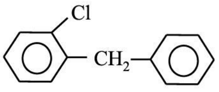
4. **(b):** $\bar{C}\equiv C-H < \bar{C}H=CH_2 < \bar{C}H_2-CH_3$

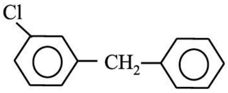
(Basic character)

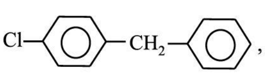
Conjugate base of stronger acid is weaker and vice-versa.

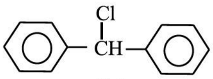
5. **(a):** Organic compounds which are volatile in steam can be purified by steam distillation.

6. **(b):** Only four structural isomers are possible for monochlorinated diphenylmethane.


(i)


(ii)


(iii)


(iv)

7. **(a)** **8.** **(c)** **9.** **(b)**

10. **(d):** Carius method is used in the estimation of sulphur or halogen in an organic compound.

11. **(b)** **12.** **(c)** **13.** **(b)**

14. **(d):** Kjeldahl's method used for the estimation of nitrogen but fails for compounds containing nitrogen in the ring (pyridine) or nitrogen directly linked to oxygen atom (nitro compounds) or another nitrogen atom (azo compounds).

15. **(d):** It will be most stable due to hyperconjugation.

16. **(d)**

17. **(c):** When treated with standard solution of alkali nitrogen is liberated as NH_3 which is absorbed in H_2SO_4 to get percentage of nitrogen.

18. **(b):** Hydrazine (NH_2NH_2) does not respond to Lassaigne's test because it does not contain any carbon and hence, NaCN is not formed.

19. **(c)**

20. **(c):** Nucleophilic substitution reaction involves the displacement of a nucleophile by another nucleophile.

21. **(7):** According to Dumas method :

$$C_xH_yN_z + \left(2x+\frac{y}{2}\right)CuO \longrightarrow xCO_2 + \frac{y}{2}H_2O + \frac{1}{2}N_2 + \left(2x+\frac{y}{2}\right)Cu$$

For C_2H_7N; $x = 2, y = 7$

22. **(40):** Molar mass of AgBr = 108 + 80

$= 188\ g\ mol^{-1}$

188 g AgBr contains 80 g bromine.

$$\text{Percentage of Br} = \frac{80\times \text{wt. of AgBr}\times 100}{188\times w}$$

$$= \frac{80\times 0.188\times 100}{188\times 0.2} = 40\%$$

23. **(23.7):** The % of N according to Kjeldahl's method,

$$= \frac{1.4\times N_1\times V}{w}$$

N_1 = Normality of the standard acid = 0.1 N

w = Mass of the organic compound taken = 29.5 mg $= 29.5\times 10^{-3}$ g

V = Volume of N_1 acid neutralised by ammonia = (20 – 15) = 5 mL

$$\Rightarrow\ \%\text{ of N} = \frac{1.4\times 0.1\times 5}{29.5\times 10^{-3}} = 23.7\%$$

24. **(73.34):** Percentage of C

$$= \frac{12}{44}\times\frac{\text{weight of } CO_2}{\text{weight of compound}}\times 100$$

$$= \frac{12}{44}\times\frac{0.147}{0.2}\times 100 = 20\%$$

$$\text{Percentage of H} = \frac{2}{18}\times\frac{0.12}{0.2}\times 100 = 6.66\%$$

Percentage of O = 100 – (20 + 6.66) = 73.34%.

25. **(7)**

MONTHLY TEST DRIVE

XI

This specially designed column enables students to self analyse their extent of understanding the specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Classification of Elements and Periodicity in Properties | Chemical Bonding and Molecular Structure

Time Taken : 60 Min.

NEET

Only One Option Correct Type

1. Which of the following is the incorrect order of first ionisation enthalpy?
(a) Sn < Pb (b) Sn < Ge
(c) Ge < Si (d) None of these

2. Which of the following order is incorrect?
(a) $NH_3 < PH_3 < AsH_3$: Acidic character
(b) Li < Be < B < C : First ionisation energy
(c) $Al_2O_3 < MgO < Na_2O < K_2O$: Basic character
(d) $Li^+ < Na^+ < K^+ < Cs^+$: Ionic character

3. In any period of the periodic table, valency of an element
(a) increases by one from IA to VIIA
(b) decreases by one from IA to VIIA
(c) increases by one from IA to IVA and then decreases from VA to VIIA one by one
(d) decreases by one from IA to IVA and then increases from VA to VIIA one by one.

4. Which of the following statements is not correct?
(a) Ionization energy increases on going down a group in the periodic table.
(b) Among alkaline earth metals, reducing character increases down the group.
(c) Fluorine is the most electronegative element.
(d) Metallic character increases on going down a group in the periodic table.

5. Assuming 2*s*-2*p* mixing is not operative, the paramagnetic species among the following is
(a) Be_2 (b) B_2 (c) C_2 (d) N_2

6. Which one of the following is the strongest base?
(a) AsH_3 (b) NH_3 (c) PH_3 (d) SbH_3

7. The nodal plane in the π-bond of ethene is located in
(a) the molecular plane
(b) a plane parallel to the molecular plane
(c) a plane perpendicular to the molecular plane which bisects the carbon-carbon sigma bond at right angles
(d) a plane perpendicular to the molecular plane which contains the carbon-carbon σ bond.

8. The size of ionic species is correctly given in order
(a) $Cl^{7+} > Si^{4+} > Mg^{2+} > Na^+$
(b) $Na^+ > Mg^{2+} > Si^{4+} > Cl^{7+}$
(c) $Na^+ > Mg^{2+} > Cl^{7+} > Si^{4+}$
(d) $Cl^{7+} > Na^+ > Mg^{2+} > Si^{4+}$

9. According to Fajan's rule, covalent bond is favoured by
(a) large cation and small anion
(b) large cation and large anion
(c) small cation and small anion
(d) small cation and large anion.

10. Which is the correct order of atomic sizes?
(a) Ce > Sn > Yb > Lu (b) Sn > Ce > Lu > Yb
(c) Lu > Yb > Sn > Ce (d) Sn > Yb > Ce > Lu.
(At. Nos. : Ce = 58, Sn = 50, Yb = 70 and Lu = 71)

11. On hybridisation of one *s* and *p* orbital, we get
(a) two mutually perpendicular orbitals
(b) two orbitals at 180°
(c) four orbitals directed tetrahedrally
(d) three orbitals in a plane.

12. Atom of which of the following elements has the greatest ability to attract electrons?
(a) Silicon (b) Sulphur
(c) Nitrogen (d) Chlorine

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Boron has a smaller first ionisation enthalpy than beryllium.

Reason : The penetration of a 2*s* electron to the nucleus is more than the 2*p* electron hence 2*p* electron is more shielded by the inner core of electrons than the 2*s* electron.

14. **Assertion :** Among the two O — H bonds in H_2O molecule, the energy required to break the first O — H bond and other O — H bond is the same.

Reason : This is because the electronic environment around oxygen is the same even after breakage of one O — H bond.

15. **Assertion :** The electron gain enthalpy of N is +ve while that of P is –ve.

Reason : This is due to the smaller atomic size of N in which there is a considerable electron-electron repulsion and hence the additional electron is not accepted easily.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Which of the following statements is not correct from the view point of molecular orbital theory?
(a) Be_2 is not a stable molecule.
(b) He_2 is not stable but He_2^+ is expected to exist.
(c) Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules belonging to the second period.
(d) The order of energies of molecular orbitals in N_2 molecule is $\sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$

17. Which of the following molecular orbitals has two nodal planes?
(a) σ_{2s} (b) π_{2py} (c) π^*_{2py} (d) σ^*_{2px}

18. Identify the correct order of acidic strength of CO_2, CuO, CaO, H_2O
(a) CaO < CuO < H_2O < CO_2
(b) H_2O < CuO < CaO < CO_2
(c) CaO < H_2O < CuO < CO_2
(d) H_2O < CO_2 < CaO < CuO

19. Oxygen is more electronegative than sulphur, yet H_2S is acidic in nature while H_2O is neutral, because
(a) H_2O molecule are associated due to inter-molecular hydrogen bonding
(b) H_2O has higher boiling point than H_2S
(c) H – S is weaker than O – H bond
(d) H_2S is gas at ordinary temperature while H_2O is liquid

More than One Option Correct Type

20. Which of the following statements are not correct?
(a) NaCl being an ionic compound is a good conductor of electricity in the solid state.
(b) In canonical structures, there is difference in the arrangement of atoms.
(c) Hybrid orbitals are stronger than pure bonds.
(d) VSEPR theory can explain the square planar geometry of XeF_4.

21. The properties which are common to both groups 1 and 17 elements in the periodic table are
(a) electropositive character increases down the groups
(b) reactivity decreases from top to bottom in these groups
(c) atomic radii increases as the atomic number increases
(d) electronegativity decreases on moving down a group.

22. In which of the following, the hybrid orbitals of the central atom have the same *s*-character?
(a) CH_4 (b) $Ni(CO)_4$
(c) SF_4 (d) $[Ni(CN)_4]^{2-}$

23. Ionisation energies of atoms *A* and *B* are 350 and 250 kcal mol^{-1} respectively. The electron affinities of these atoms are 70 and 90 kcal mol^{-1} respectively. Then
(a) electron cloud is more attracted by *A*
(b) electron cloud is more attracted by *B*

UNSCRAMBLED WORDS

FEBRUARY 2023

1-c-AMYLASE
2-d-ALDRIN
3-a-DEMULSIFICATION
4-e-ELECTROPHORESIS
5-b-HYDROMETER
6-h-ISOTROPIC
7-f-LATEX
8-i-MOLECULARITY
9-g-KETENES
10-j-PHOTOSENSITIZATION

Winners : *Polam Naresh, Kaushikkumar Kevadiya*

(c) on Mulliken scale, electronegativity of *A* is more than *B*
(d) on Mulliken scale, electronegativity of *A* is less than *B*.

Integer / Numerical Value Type

24. Complexes (ML_5) of metals Ni and Fe have ideal square pyramidal and trigonal bipyramidal geometries, respectively. The sum of the 90°, 120° and 180° *L-M-L* angles in the two complexes is ______.

25. If the ionization enthalpy and electron gain enthalpy of an element are 275 and 86 kcal mol^{-1} respectively, then the electronegativity of the element on the Pauling scale is ______.

26. Consider the following species :
$O(Me)_2$, $N(SiH_3)_3$, CO, $O(SiH_3)_2$, OCl_2, CCl_3^-, H_4SiO_4, MeNCS.
Then, the total number of species which have ($p\pi$-$p\pi$) back bonds or ($p\pi$-$d\pi$) back bonds is____.

Comprehension Type

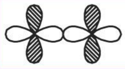
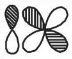
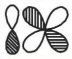
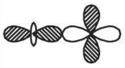
Hybridisation is defined as the phenomenon of mixing of orbitals of nearly the same energy so as to redistribute their energies and to give rise to new orbitals of equivalent energy. It is the valence shell atomic orbitals of the central atom which get hybridised. One of the electrons from an orbital in the ground state electronic configuration of the atom gets promoted to the next available orbital of higher energy resulting in an excited state electronic configuration with the appropriate number of half filled orbitals. The orbitals in the excited state undergo hybridisation giving hybrid orbitals of equivalent energy. Hybrid orbitals generally form either bonds or contain lone pair of electrons, they do not form π bonds. Hybridised orbitals can overlap in a greater extent due to their greater extension in space. Bonds formed by the overlap of hybrid orbitals gives a particular shape to a molecule. Depending on the type of orbitals used the hybridisation may be categorised as *sp*(linear), sp^2(trigonal planar), sp^3(tetrahedral), sp^3d(trigonal bipyramidal), sp^3d^2(octahedral), sp^3d^3(pentagonal bipyramidal), etc.

27. The strength of sigma bonds formed by *s–s*, *p–p* and *s–p* axial overlap is in the order of
(a) $s–s < s–p < p–p$ (b) $s–s > p–p > s–p$
(c) $s–p > s–s > p–p$ (d) $p–p > s–s > s–p$

28. The non-linear structure is assumed by
(a) $SnCl_2$ (b) NCO^- (c) NO_2^+ (d) CS_2

Matching Type

29. Match the orbital overlap figures shown in Column I with the description given in Column II and select the correct option.

Column I		Column II	
(P)		1.	*p - d* π antibonding
(Q)		2.	*d - d* σ bonding
(R)		3.	*p - d* π bonding
(S)		4.	*d - d* σ antibonding

	P	Q	R	S
(a)	2	1	3	4
(b)	4	3	1	2
(c)	2	3	1	4
(d)	4	1	3	2

30. Match the oxides given in Column I with their property given in Column II and select the correct option.

Column I		Column II	
(i)	Na_2O	A.	Neutral
(ii)	Al_2O_3	B.	Basic
(iii)	N_2O	C.	Acidic
(iv)	Cl_2O_7	D.	Amphoteric

(a) (i)-B, (ii)-A, (iii)-D, (iv)-C
(b) (i)-C, (ii)-B, (iii)-A, (iv)-D
(c) (i)-A, (ii)-D, (iii)-B, (iv)-C
(d) (i)-B, (ii)-D, (iii)-A, (iv)-C

◆◆

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No. of questions correct ......
Marks scored in percentage ......

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CLASS-XII

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Unit 7 Aldehydes, Ketones and Carboxylic Acids | Organic Compounds Containing Nitrogen

Aldehydes, Ketones

ALDEHYDES AND KETONES

- These are the compounds having a carbonyl group >C=O.
- Aldehydes contain a free hydrogen attached to carbonyl group while ketones do not have any free hydrogen attached to carbonyl group.

NOMENCLATURE

- The IUPAC names of open chain aliphatic aldehydes and ketones are derived from the names of the corresponding alkanes by replacing the ending *–e* with *–al* and *–one* respectively.

STRUCTURE

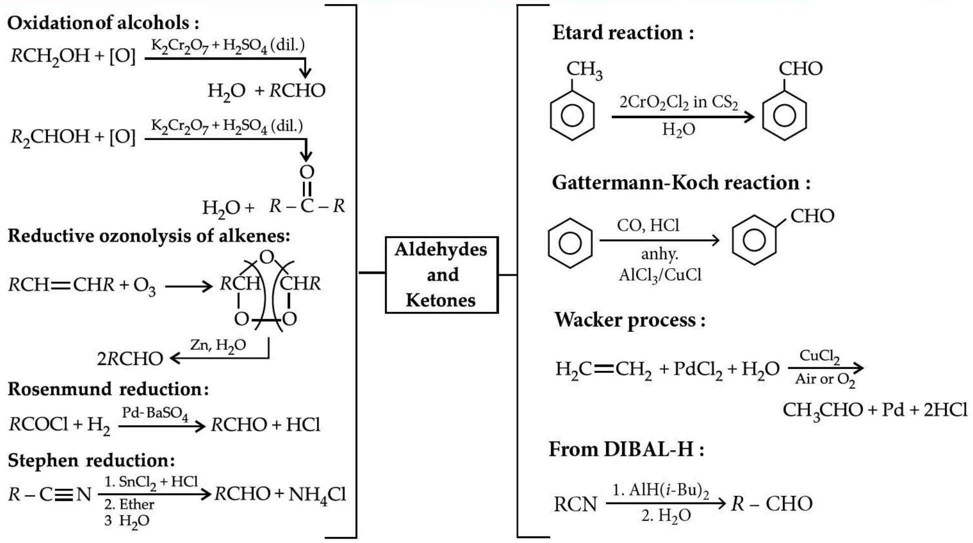
- The carbon of carbonyl group is sp^2 hybridised.

The C—O bond has a double bond character and composed of a σ and a p bond $\left(\gt \overset{\delta+}{C}=\overset{\delta-}{O}\right)$. The bond is polar in character and therefore, it has a dipole moment of 2.3 – 2.8 D.

- **Polar nature of carbonyl group :**
  - Due to high electronegativity of O-atom, π-electrons cloud of $\gt C=O$ is unsymmetrical. Oxygen atom acquires a small negative charge and carbon becomes slightly positively charged, hence carbonyl compounds undergo nucleophilic addition reactions. The C—O bond is a resonance hybrid of the following structures :

$$\underset{\mu = 2.3\text{ D}}{\gt C=O} \longleftrightarrow \underset{\mu = 2.8\text{ D}}{\gt \overset{+}{C}-\overset{-}{O}}$$

METHODS OF PREPARATION



Oxidation of alcohols :

$$RCH_2OH + [O] \xrightarrow{K_2Cr_2O_7 + H_2SO_4\,(dil.)} H_2O + RCHO$$

$$R_2CHOH + [O] \xrightarrow{K_2Cr_2O_7 + H_2SO_4\,(dil.)} H_2O + R-\overset{O}{\overset{\|}{C}}-R$$

Reductive ozonolysis of alkenes:

$$RCH=CHR + O_3 \longrightarrow \text{ozonide} \xrightarrow{Zn,\ H_2O} 2RCHO$$

Rosenmund reduction:

$$RCOCl + H_2 \xrightarrow{Pd\text{-}BaSO_4} RCHO + HCl$$

Stephen reduction:

$$R-C\equiv N \xrightarrow[\text{2. Ether}\ \ 3\ H_2O]{1.\ SnCl_2 + HCl} RCHO + NH_4Cl$$

Aldehydes and Ketones

Etard reaction :

$$C_6H_5CH_3 \xrightarrow[H_2O]{2CrO_2Cl_2\text{ in }CS_2} C_6H_5CHO$$

Gattermann-Koch reaction :

$$C_6H_6 \xrightarrow[\text{anhy. } AlCl_3/CuCl]{CO,\ HCl} C_6H_5CHO$$

Wacker process :

$$H_2C=CH_2 + PdCl_2 + H_2O \xrightarrow[\text{Air or } O_2]{CuCl_2} CH_3CHO + Pd + 2HCl$$

From DIBAL-H :

$$RCN \xrightarrow[2.\ H_2O]{1.\ AlH(i\text{-}Bu)_2} R-CHO$$

PHYSICAL PROPERTIES

Physical state and odour : Lower members of aldehydes and ketones (upto C_{10}) are colourless volatile liquids except formaldehyde which is gas at ordinary temperature.

Higher members of aldehydes and ketones are solids with fruity odour.

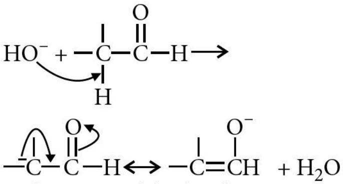
- **Solubility :** Lower members of aldehydes and ketones (upto C_4) are soluble in water due to H-bonding between polar carbonyl group and water.
- **Boiling point :** Slightly lower than corresponding alcohol due to lack of hydrogen bonding.

CHEMICAL PROPERTIES

Polar nature of carbonyl group : Aldehydes (*R*CHO) and ketones (*R*CO*R*) contain a polar C═O bond.

Acidity of α-H : The α-hydrogens of aldehydes and ketones are weakly acidic due to :

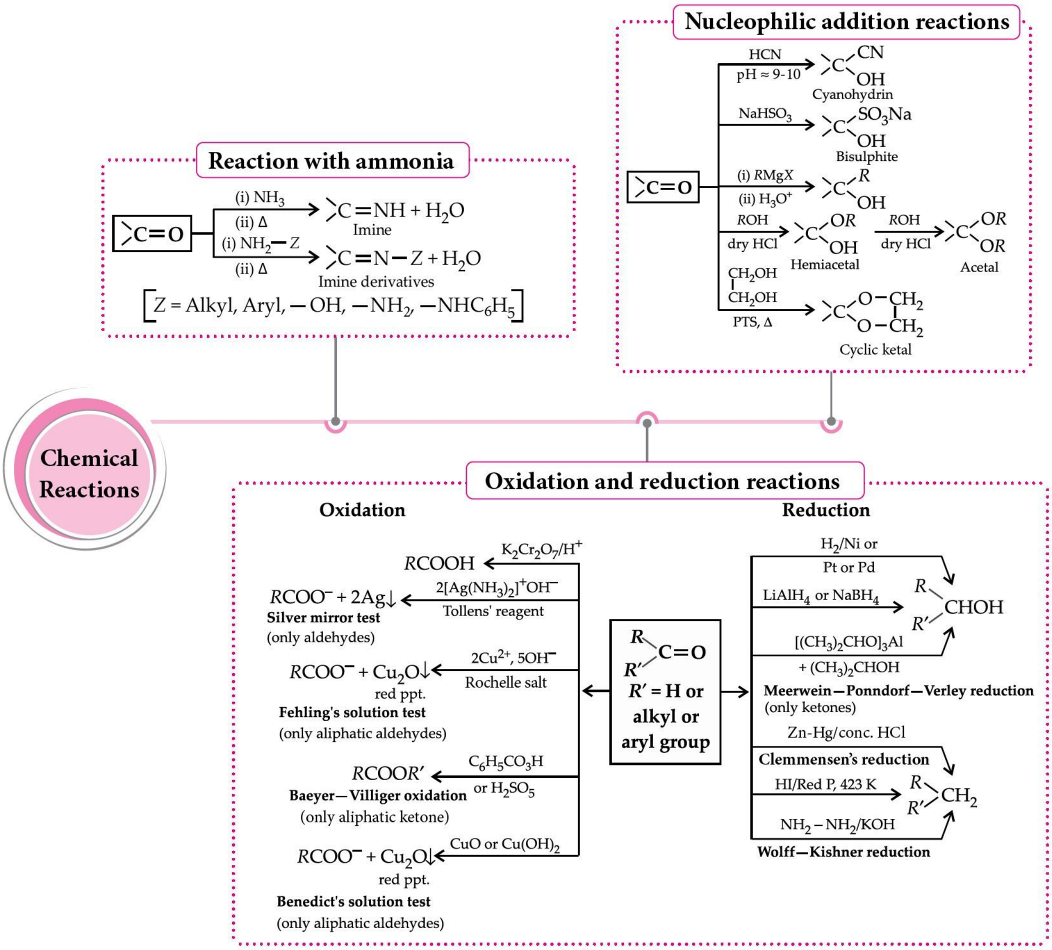
- – *M*-effect of the C═O group reduces the electron density in the C_α—H bond.
- the carbanion or the enolate ion formed after the removal of the proton is stabilised by resonance.



$HO^- + -\overset{|}{\underset{H}{C}}-\overset{O}{\overset{\|}{C}}-H \rightarrow$
$-\overset{|}{C}-\overset{O}{\overset{\|}{C}}-H \leftrightarrow -\overset{|}{C}=\overset{O^-}{\overset{|}{C}}H + H_2O$

Resonance stabilised enolate ion

CHEMICAL REACTIONS



Chemical Reactions
Reaction with ammonia
>C=O
(i) NH_3 (ii) Δ
>C=NH + H_2O
Imine
(i) NH_2—Z (ii) Δ
>C=N−Z + H_2O
Imine derivatives
[Z = Alkyl, Aryl, —OH, —NH_2, —NHC_6H_5]
Nucleophilic addition reactions
>C=O
HCN, pH ≈ 9-10
>C(CN)(OH)
Cyanohydrin
$NaHSO_3$
>C(SO_3Na)(OH)
Bisulphite
(i) *R*MgX (ii) H_3O^+
>C(*R*)(OH)
*R*OH, dry HCl
>C(O*R*)(OH)
Hemiacetal
*R*OH, dry HCl
>C(O*R*)(O*R*)
Acetal
CH_2OH–CH_2OH, PTS, Δ
>C(O−CH_2)(O−CH_2)
Cyclic ketal
Oxidation and reduction reactions
Oxidation
Reduction
R>C=O, *R′*
R′ = H or alkyl or aryl group
$K_2Cr_2O_7/H^+$
*R*COOH
$2[Ag(NH_3)_2]^+OH^-$
Tollens' reagent
$RCOO^-$ + 2Ag↓
Silver mirror test
(only aldehydes)
$2Cu^{2+}$, $5OH^-$
Rochelle salt
$RCOO^-$ + Cu_2O↓
red ppt.
Fehling's solution test
(only aliphatic aldehydes)
$C_6H_5CO_3H$ or H_2SO_5
*R*COO*R′*
Baeyer—Villiger oxidation
(only aliphatic ketone)
CuO or $Cu(OH)_2$
$RCOO^-$ + Cu_2O↓
red ppt.
Benedict's solution test
(only aliphatic aldehydes)
H_2/Ni or Pt or Pd
$LiAlH_4$ or $NaBH_4$
R, *R′*>CHOH
$[(CH_3)_2CHO]_3Al$ + $(CH_3)_2CHOH$
Meerwein—Ponndorf—Verley reduction
(only ketones)
Zn-Hg/conc. HCl
Clemmensen's reduction
HI/Red P, 423 K
R, *R′*>CH_2
NH_2-NH_2/KOH
Wolff—Kishner reduction

Distinction between Aldehydes and Ketones

Tests with	Aldehydes	Ketones
Schiff's reagent	Pink colour	No colour
Fehling's solution	Red precipitate	No precipitate
Tollens' reagent	Black precipitate of silver or silver mirror	No black ppt. or silver mirror

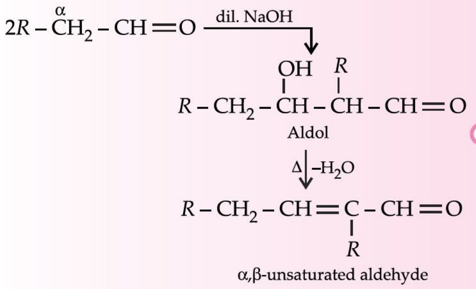
SOME NAME REACTIONS

Haloform reaction : Given by methyl ketones (even acetaldehydes).

$$2NaOH + I_2 \longrightarrow NaI + NaOI + H_2O$$

$$RCOCH_3 + 3NaOI \longrightarrow RCOONa + \underset{\substack{\text{Iodoform}\\\text{(yellow ppt.)}}}{CHI_3\downarrow} + 2NaOH$$

Aldol condensation : Aldehyde or ketone containing α-hydrogen on heating with dilute NaOH gives β-hydroxycarbonyl compound called aldol.



$$2R-\overset{\alpha}{C}H_2-CH{=}O \xrightarrow{\text{dil. NaOH}} \underset{\text{Aldol}}{R-CH_2-\overset{OH}{\overset{|}{C}H}-\overset{R}{\overset{|}{C}H}-CH{=}O} \xrightarrow[-H_2O]{\Delta} \underset{\alpha,\beta\text{-unsaturated aldehyde}}{R-CH_2-CH{=}\underset{R}{\underset{|}{C}}-CH{=}O}$$

Cannizzaro reaction : Given by aldehydes which have no α-hydrogen atom.

e.g., $2C_6H_5CHO + NaOH \xrightarrow{\Delta} C_6H_5CH_2OH + C_6H_5COONa$

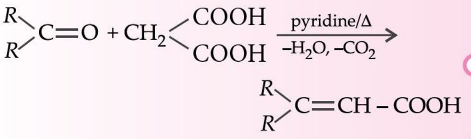
Crossed Cannizzaro reaction takes place between two different aldehydes and that aldehyde undergoes oxidation which is more reactive towards the nucleophile while the other aldehyde is reduced.

e.g., $C_6H_5CHO + HCHO \xrightarrow{NaOH,\ \Delta} C_6H_5CH_2OH + HCOONa$

Intramolecular Cannizzaro reaction is given by dialdehydes having no α-hydrogen.

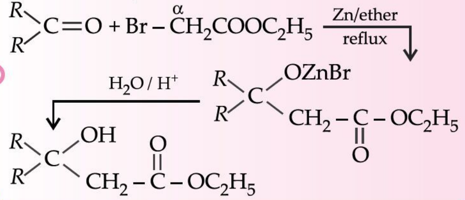
Name reactions

Knoevenagel reaction



$$R_2C{=}O + CH_2(COOH)_2 \xrightarrow[-H_2O,\ -CO_2]{\text{pyridine}/\Delta} R_2C{=}CH-COOH$$

Reformatsky reaction

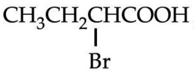


$$R_2C{=}O + Br-\overset{\alpha}{C}H_2COOC_2H_5 \xrightarrow[\text{reflux}]{\text{Zn/ether}} R_2C(OZnBr)CH_2-\overset{O}{\overset{||}{C}}-OC_2H_5 \xrightarrow{H_2O/H^+} R_2C(OH)CH_2-\overset{O}{\overset{||}{C}}-OC_2H_5$$

Carboxylic Acids

- Organic compounds containing –COOH as the functional group are called carboxylic acids. The –COOH group which itself is made up of a carbonyl group ($>C=O$) and a hydroxyl group (–OH) is called carboxyl group (*carb* from carbonyl and *oxyl* from hydroxyl).
- General formula : $C_nH_{2n}O_2$
- While writing IUPAC name of carboxylic acid, '*e*' of alkane is replaced by '*oic*' acid.

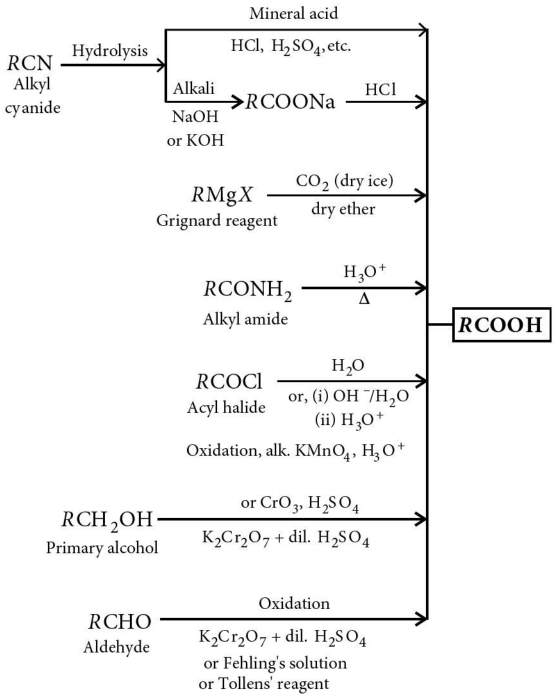
e.g.,



$CH_3CH_2\underset{\displaystyle Br}{\underset{|}{C}}HCOOH$, $C_6H_5CH_2CH_2COOH$

2-Bromobutanoic acid, 3-Phenylpropanoic acid

METHODS OF PREPARATION



RCN
Alkyl cyanide
Hydrolysis
Mineral acid
HCl, H2SO4, etc.
Alkali
NaOH or KOH
RCOONa
HCl
RMgX
Grignard reagent
CO2 (dry ice)
dry ether
RCONH2
Alkyl amide
H3O+
Δ
RCOOH
RCOCl
Acyl halide
H2O
or, (i) OH−/H2O
(ii) H3O+
Oxidation, alk. KMnO4, H3O+
or CrO3, H2SO4
RCH2OH
Primary alcohol
K2Cr2O7 + dil. H2SO4
RCHO
Aldehyde
Oxidation
K2Cr2O7 + dil. H2SO4
or Fehling's solution
or Tollens' reagent

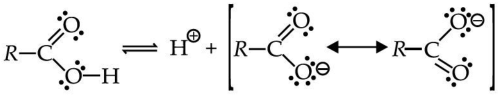
Note: Primary alcohol and aldehyde give acids containing the same number of C atoms as alcohol or aldehyde.

PHYSICAL PROPERTIES

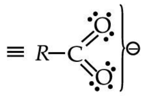
- **Physical state :** The lower fatty acids upto C_9 are colourless liquids. The higher ones are colourless waxy solids.
- **Odour :** The first three members have a sharp pungent odour. The middle ones, C_4 to C_9, have an odour of rancid butter. The higher members do not possess any smell.
- **Boiling points :** Carboxylic acids have higher boiling liquids than aldehydes, ketones and even alcohols of comparable molecular masses due to more extensive association of their molecules through intermolecular hydrogen bonding.
- **Solubility :** Simple aliphatic carboxylic acids having upto four carbon atoms are miscible in water due to the formation of hydrogen bonds with water.

CHEMICAL PROPERTIES

Acidic Nature : Carboxylic acids are weaker acids than mineral acids but they are stronger acids than alcohols and many simple phenols. The carboxyl group and carboxylate anion are stabilised by resonance, however, the stabilisation of anion will be much more than that of carboxylic acid. The carboxylate ion is stabilised by two equivalent resonance structures in which the negative charge is at the more electronegative atom.



Carboxylate anion



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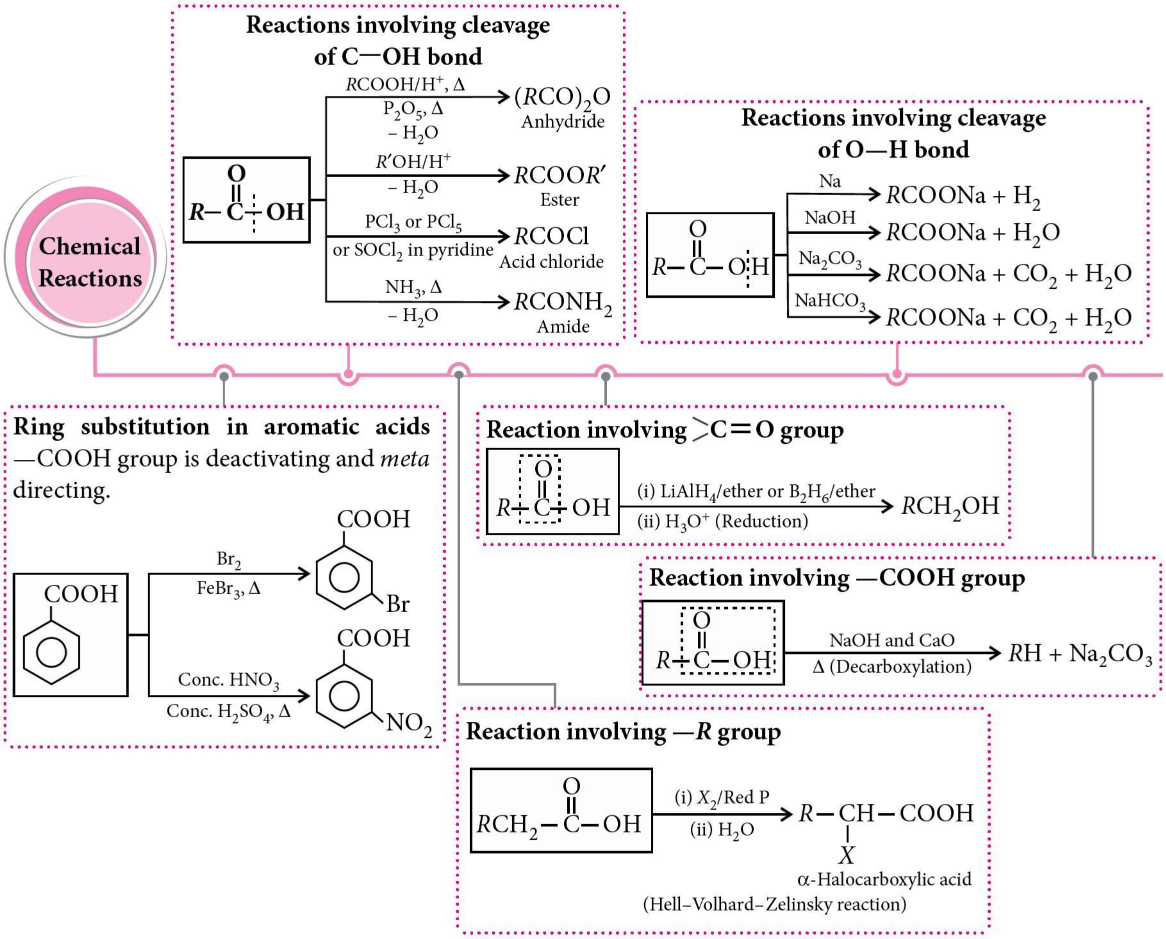
CHEMICAL REACTIONS



Reactions involving cleavage of C—OH bond

$R-\overset{O}{\overset{||}{C}}-OH \xrightarrow[P_2O_5,\ \Delta;\ -H_2O]{RCOOH/H^+,\ \Delta} (RCO)_2O$ Anhydride

$\xrightarrow[-H_2O]{R'OH/H^+} RCOOR'$ Ester

$\xrightarrow[\text{or } SOCl_2 \text{ in pyridine}]{PCl_3 \text{ or } PCl_5} RCOCl$ Acid chloride

$\xrightarrow[-H_2O]{NH_3,\ \Delta} RCONH_2$ Amide

Reactions involving cleavage of O—H bond

$R-\overset{O}{\overset{||}{C}}-O-H \xrightarrow{Na} RCOONa + H_2$

$\xrightarrow{NaOH} RCOONa + H_2O$

$\xrightarrow{Na_2CO_3} RCOONa + CO_2 + H_2O$

$\xrightarrow{NaHCO_3} RCOONa + CO_2 + H_2O$

Ring substitution in aromatic acids
—COOH group is deactivating and *meta* directing.

$C_6H_5COOH \xrightarrow[FeBr_3,\ \Delta]{Br_2}$ 3-bromobenzoic acid (COOH, Br)

$C_6H_5COOH \xrightarrow[\text{Conc. } H_2SO_4,\ \Delta]{\text{Conc. } HNO_3}$ 3-nitrobenzoic acid (COOH, NO_2)

Reaction involving $>C=O$ group

$R-\overset{O}{\overset{||}{C}}-OH \xrightarrow[\text{(ii) } H_3O^+ \text{ (Reduction)}]{\text{(i) } LiAlH_4/\text{ether or } B_2H_6/\text{ether}} RCH_2OH$

Reaction involving —COOH group

$R-\overset{O}{\overset{||}{C}}-OH \xrightarrow[\Delta \text{ (Decarboxylation)}]{\text{NaOH and CaO}} RH + Na_2CO_3$

Reaction involving —*R* group

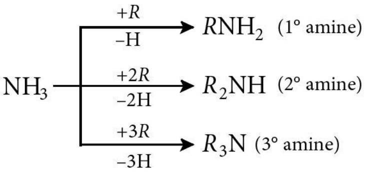
$RCH_2-\overset{O}{\overset{||}{C}}-OH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } X_2/\text{Red P}} R-\underset{X}{\underset{|}{C}H}-COOH$

α-Halocarboxylic acid
(Hell–Volhard–Zelinsky reaction)

Organic Compounds Containing Nitrogen

AMINES

These are alkyl or aryl derivatives of ammonia, hence may be classified as follows :



$NH_3 \xrightarrow[-H]{+R} RNH_2$ (1° amine)

$NH_3 \xrightarrow[-2H]{+2R} R_2NH$ (2° amine)

$NH_3 \xrightarrow[-3H]{+3R} R_3N$ (3° amine)

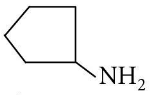
When hydrogen atoms of ammonia are replaced by one, two or three aromatic rings, they are called as 1°, 2° and 3° aryl amines respectively.

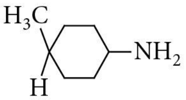
Nomenclature

Aliphatic amines are called as alkanamines in which '*e*' of alkane is replaced by amine. For example,

$CH_3-CH_2NH_2$
Ethanamine

$CH_3-CH_2-CH_2-NH_2$
Propan-1-amine or 1-propanamine


Cyclopentanamine


4-Methylcyclohexanamine

The secondary and tertiary amines are named as nitrogen substituted primary amine *i.e.*, *N*-alkylaminoalkanes (for 2° amine) and *N*, *N*-dialkylaminoalkanes (for 3° amine). The largest alkyl part is considered as a part of

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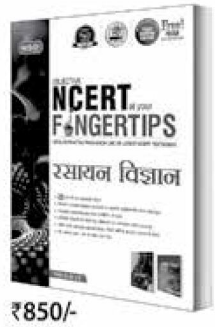
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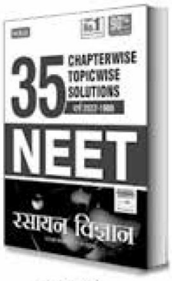
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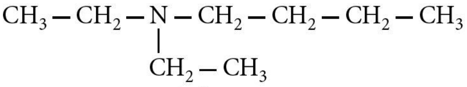
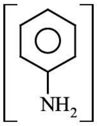
aminoalkane. *N*– and *N*, *N*– means that alkyl groups are linked to N-atom, not to carbon atom. For example,

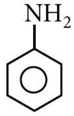


$$CH_3-CH_2-\underset{\displaystyle CH_2-CH_3}{\underset{|}{N}}-CH_2-CH_2-CH_2-CH_3$$

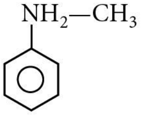
N, *N*-Diethylbutan-1-amine

The simplest aromatic amine is aniline and other aromatic amines are considered as aniline derivatives.

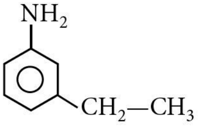
According to IUPAC system, aromatic amine  is called as benzamine. Other aromatic amines are named as derivatives of benzamine and the positions of the other groups are indicated by the numbers.



Aminobenzene
or
Benzamine

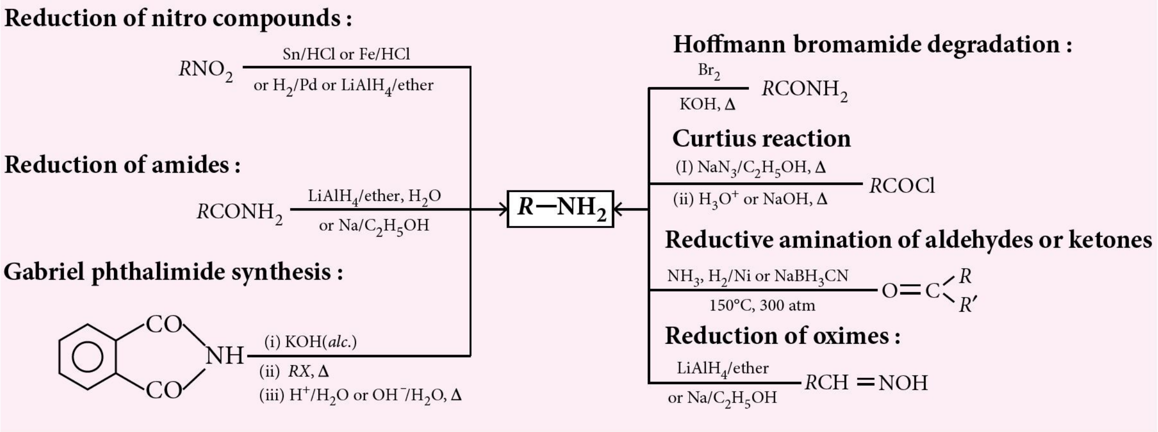


N-methylbenzamine
or
N-methylaminobenzene



3-Ethylbenzamine
or
3-Ethylaminobenzene

Methods of Preparation



Reduction of nitro compounds :
RNO_2
Sn/HCl or Fe/HCl
or H_2/Pd or $LiAlH_4$/ether
Reduction of amides :
$RCONH_2$
$LiAlH_4$/ether, H_2O
or Na/C_2H_5OH
Gabriel phthalimide synthesis :
CO
NH
CO
(i) KOH(*alc.*)
(ii) *RX*, Δ
(iii) H^+/H_2O or OH^-/H_2O, Δ
R—NH_2
Hoffmann bromamide degradation :
Br_2
KOH, Δ
$RCONH_2$
Curtius reaction
(I) NaN_3/C_2H_5OH, Δ
(ii) H_3O^+ or NaOH, Δ
$RCOCl$
Reductive amination of aldehydes or ketones
NH_3, H_2/Ni or $NaBH_3CN$
150°C, 300 atm
O=C R R′
Reduction of oximes :
$LiAlH_4$/ether
or Na/C_2H_5OH
RCH =NOH

Physical Properties

Physical state and odour

Lower aliphatic amines are gases which smell like ammonia and lower aromatic amines are liquids with characteristic unpleasant odour.

Solubility

- Amines are soluble in water due to hydrogen bonding while higher amines and aromatic amines are soluble in organic solvents such as benzene, ether, alcohol, etc.
- As the size of the alkyl group increases, solubility decreases.

Boiling point

- Tertiary amines have the lowest boiling points as they do not have hydrogen atoms linked to the nitrogen atom.
- The intermolecular association is more in primary amines than in secondary amines due to the presence of two hydrogen atoms. Therefore, the order of boiling points of isomeric amines is 1° > 2° > 3°.

Colour

Pure amines are colourless but develop colour when exposed to air.

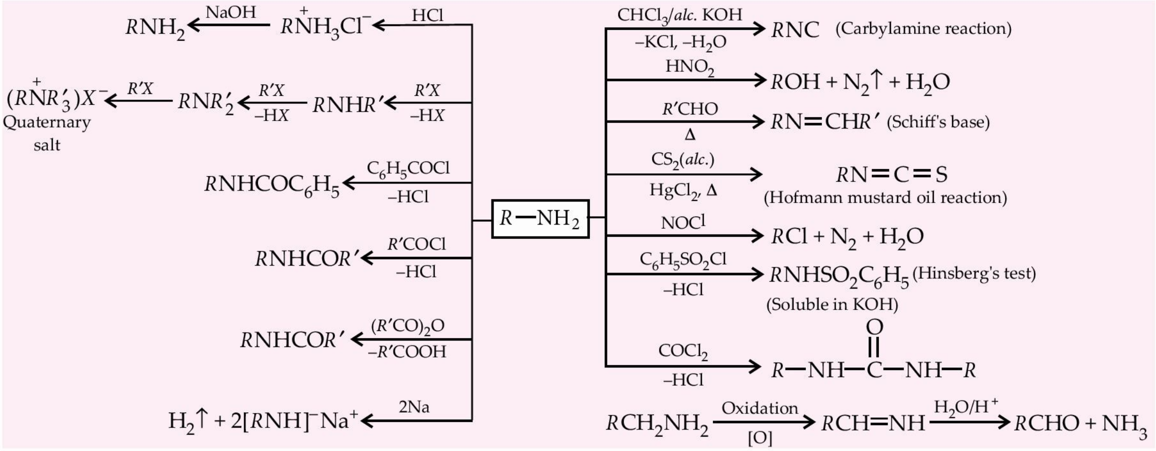
Chemical Properties

- **Basic character**
  - In gaseous phase, the order of basicity of amines is : 3° amine > 2° amine > 1° amine > NH_3.
  - In aqueous phase, despite of inductive effect, solvation effect and steric hindrance also play an important role. Thus, the order of basicity in aqueous solution of amines is as follows :

    $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$

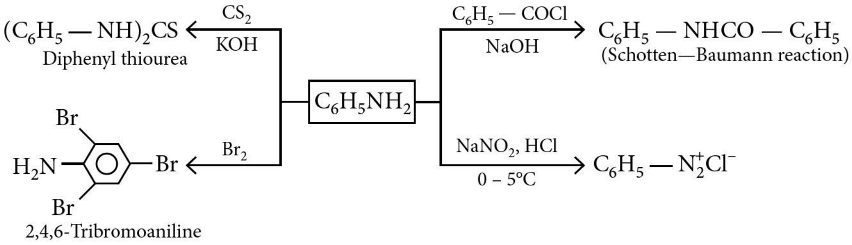
    $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$
  - Aniline is less basic than alkylamines due to the delocalization of lone pair of electrons of nitrogen atom over benzene ring. Moreover, the anilinium ion obtained by accepting a proton have only two resonating structures and is less stable than aniline.

- **Chemical Reactions**



R—NH₂
RNH₂ ← NaOH ← RN⁺H₃Cl⁻ ← HCl
(RN⁺R′₃)X⁻ ← R′X ← RNR′₂ ← R′X, –HX ← RNHR′ ← R′X, –HX
Quaternary salt
RNHCOC₆H₅ ← C₆H₅COCl, –HCl
RNHCOR′ ← R′COCl, –HCl
RNHCOR′ ← (R′CO)₂O, –R′COOH
H₂↑ + 2[RNH]⁻Na⁺ ← 2Na
CHCl₃/alc. KOH, –KCl, –H₂O → RNC (Carbylamine reaction)
HNO₂ → ROH + N₂↑ + H₂O
R′CHO, Δ → RN=CHR′ (Schiff's base)
CS₂(alc.), HgCl₂, Δ → RN=C=S (Hofmann mustard oil reaction)
NOCl → RCl + N₂ + H₂O
C₆H₅SO₂Cl, –HCl → RNHSO₂C₆H₅ (Hinsberg's test) (Soluble in KOH)
COCl₂, –HCl → R—NH—C(=O)—NH—R
RCH₂NH₂ → Oxidation [O] → RCH=NH → H₂O/H⁺ → RCHO + NH₃

- **Reactions of aniline :**



C₆H₅NH₂
(C₆H₅—NH)₂CS ← CS₂, KOH
Diphenyl thiourea
Br₂
2,4,6-Tribromoaniline
C₆H₅—COCl, NaOH → C₆H₅—NHCO—C₆H₅ (Schotten—Baumann reaction)
NaNO₂, HCl, 0 – 5°C → C₆H₅—N₂⁺Cl⁻

DIAZONIUM SALT

- These have the general formula, $ArN_2^+X^-$, where Ar is abbriviated for the aryl group and X^- can be Cl^-, Br^-, HSO_4^-, NO_3^-, etc.

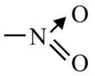
PREPARATION

$$ArNH_2 + NaNO_2 + 2HX \xrightarrow{273\text{-}278\ K} ArN_2^+X^- + NaX + 2H_2O$$

CHEMICAL PROPERTIES

DIAZONIUM SALT	**Balz-Schiemann reaction** $\xrightarrow[-HCl]{HBF_4} ArN_2^+BF_4^- \xrightarrow{\Delta} ArF + N_2 + BF_3$
	$\xrightarrow[\text{or } CH_3CH_2OH/\Delta]{H_3PO_2/Cu^+} ArH$
	Sandmeyer's reaction $\xrightarrow{CuBr/HBr} ArBr + N_2$
	Gattermann reaction $\xrightarrow{Cu/HBr} ArBr + N_2$

NITRO COMPOUNDS

The functional group of nitro compounds is 

PREPARATION OF ALIPHATIC NITRO COMPOUNDS

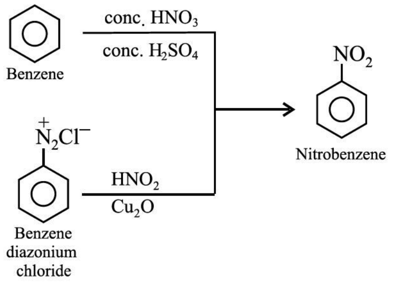
By heating alkyl halide with $AgNO_2$ in aqueous ethanolic solution :

$$RX + AgNO_2 \longrightarrow RNO_2 + AgX$$

By heating hydrocarbon with nitric acid :

$$CH_3{-}CH_2{-}CH_3 \xrightarrow[400°C]{HNO_3} CH_3CH_2CH_2NO_2 + CH_3CH(NO_2)CH_3 + CH_3CH_2NO_2 + CH_3NO_2$$

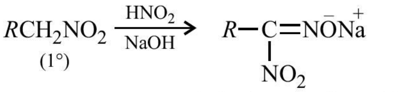
Preparation of Nitrobenzene



Chemical Properties

$$RNO_2 \xrightarrow{LiAlH_4} RNH_2\ ;\ RNO_2 \xrightarrow[6[H]]{Sn/HCl} RNH_2 + 2H_2O$$

$$RCH_2NO_2 + H_2O \xrightarrow{H^+} RCOOH + NH_2OH$$



$$\underset{(1°)}{RCH_2NO_2} \xrightarrow[NaOH]{HNO_2} R{-}\underset{NO_2}{\underset{|}{C}}{=}N\bar{O}\overset{+}{Na}$$

(Red coloured sodium salt)

CYANIDES AND ISOCYANIDES

- General Formula of cyanides is $R{-}C{\equiv}N$ and isocyanides is $R{-}N\overset{\rightarrow}{=}C$.

Preparation of Cyanides

$$RX + KCN \longrightarrow RCN + KX$$

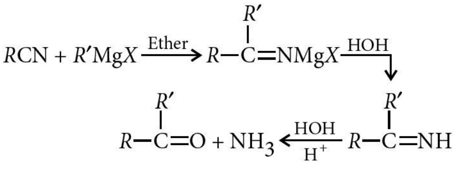
$$RCONH_2 \xrightarrow[\Delta]{P_2O_5} RC{\equiv}N + H_2O$$

$$CH_3CH{=}NOH \xrightarrow[-H_2O]{P_2O_5} CH_3C{\equiv}N$$

$$RMgBr + Cl{-}CN \longrightarrow RCN + MgBrCl$$

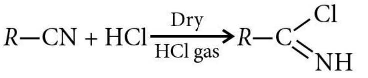
$$RCH_2NH_2 \xrightarrow[773\ K]{Cu} RCN + 2H_2$$

Chemical Properties of Cyanides



$$RCN + R'MgX \xrightarrow{Ether} R{-}\overset{R'}{\overset{|}{C}}{=}NMgX \xrightarrow{HOH} R{-}\overset{R'}{\overset{|}{C}}{=}NH \xrightarrow[H^+]{HOH} R{-}\overset{R'}{\overset{|}{C}}{=}O + NH_3$$

$$RCN + R'OH + HCl \xrightarrow{H_2O} RCOOR' + NH_4Cl$$



Imino chloride

$$CH_3CN + H_2O \xrightarrow{H_2O_2/OH^-} CH_3CONH_2$$

Stephen's reaction :

$$R{-}CN \xrightarrow[2[H]]{SnCl_2/HCl} RCH{=}NH{\cdot}HCl \xrightarrow{H_2O} RCHO + NH_4Cl$$

$$R{-}CN + 2[H] \xrightarrow[195\ K]{DIBAL\text{-}H} RCH{=}NH \xrightarrow{H_2O/H^+} RCHO$$

Preparation of Isocyanides

$$RI + AgCN \xrightarrow[\Delta]{C_2H_5OH} RN\overset{\rightarrow}{=}C + AgI$$

$$RNH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} RN\overset{\rightarrow}{=}C + 3KCl + 3H_2O$$

$$\boxed{RN\overset{\rightarrow}{=}C}$$

Chemical Properties of Isocyanides

$$CH_3N\overset{\rightarrow}{=}C + 2H_2O \xrightarrow{H^+\ or\ OH^-} CH_3NH_2 + HCOOH$$

$$CH_3N\overset{\rightarrow}{=}C + 2H_2 \xrightarrow[Na/C_2H_5OH]{Ni/Pt\ or} CH_3NHCH_3$$

$$RNC \xrightarrow{\Delta} RCN$$

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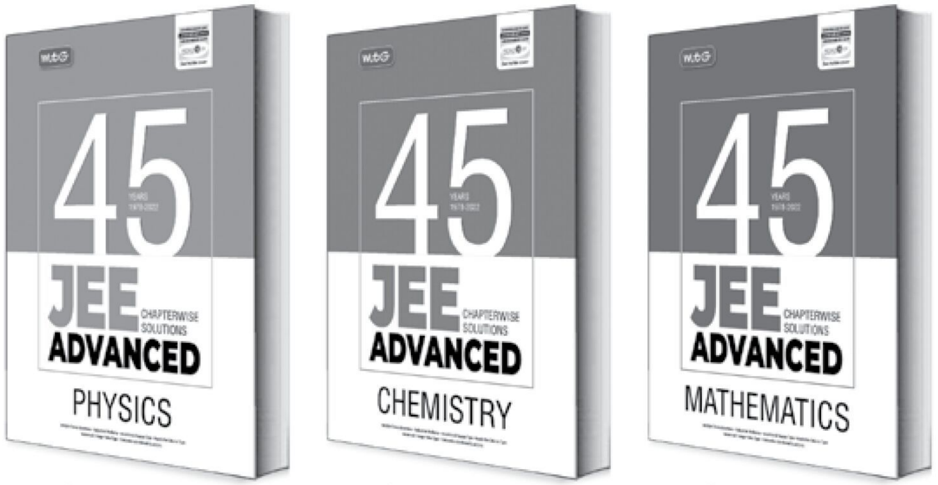

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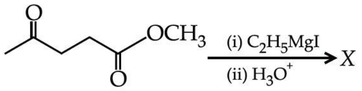
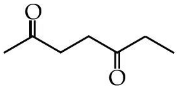
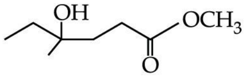
WRAP it up!

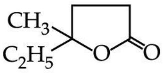
MCQs TYPE QUESTIONS

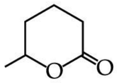
1. The structure of the compound *X* formed in the following reaction is



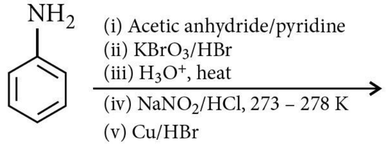
(a)


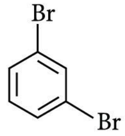
(b)


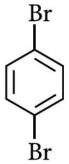
(c)


(d)


2. The product(s) of the following reaction sequence is(are)



(a)


(b)


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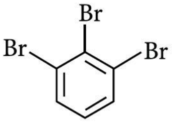
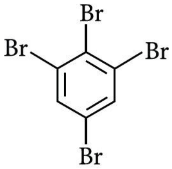


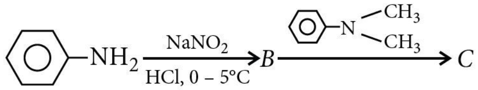
(d)


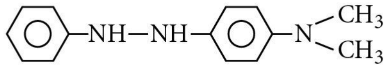
3. Identify '*D*' in the following reaction :

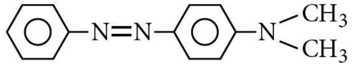
$$\begin{tikzcd}
CH\equiv CH + CH_3MgBr \arrow[r, "-CH_4"'] & A \arrow[r, "\text{(i) } CO_2", "\text{(ii) } H_3O^+"'] & B \arrow[d, "HgSO_4/H_2SO_4"] \\
& D & C \arrow[l, "\text{Tautomerisation}"']
\end{tikzcd}$$

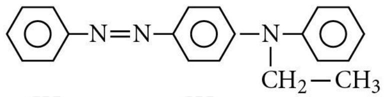
(a) $HOOC-CH_2-COOH$
(b) $OHC-CH_2-COOH$
(c) $OHC-CH_2-CHO$
(d) $HO-CH=CH-COOH$

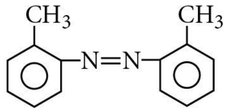
4. In a reaction of aniline a coloured compound '*C*' was obtained. The structure of '*C*' would be



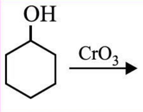
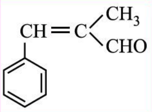
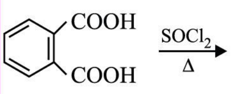
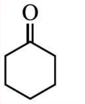
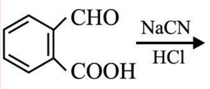
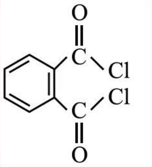
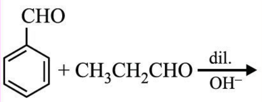
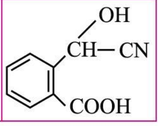
(a)


(b)


(c)


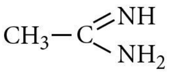
(d)


5. Match the column I with column II and mark the appropriate choice.

	Column I		Column II
(A)		(i)	
(B)		(ii)	
(C)		(iii)	
(D)		(iv)	

(a) (A) → (ii), (B) → (i), (C) → (iii), (D) → (iv)
(b) (A) → (iii), (B) → (iv), (C) → (i), (D) → (ii)
(c) (A) → (iv), (B) → (i), (C) → (ii), (D) → (iii)
(d) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)

6. The correct order of basicities of the following compounds is



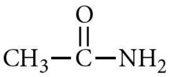
1

$CH_3-CH_2-NH_2$

2

$(CH_3)_2NH$

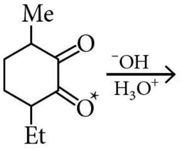
3

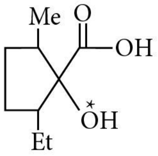


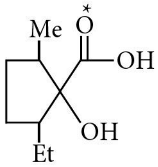
$CH_3-\overset{\overset{O}{\|}}{C}-NH_2$

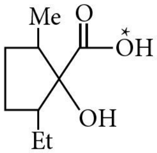
4

(a) 2 > 1 > 3 > 4
(b) 1 > 3 > 2 > 4
(c) 3 > 1 > 2 > 4
(d) 1 > 2 > 3 > 4

7.  (*B*). Compound (*B*) is

(a) 

(b) 

(c) 

(d) All of these

8. An organic compound '*A*' having molecular formula, C_2H_3N on reduction gave another compound '*B*'. Upon treatment with nitrous acid '*B*' gave ethyl alcohol. On warming with chloroform and alcoholic KOH, '*B*' forms an offensive smelling compound '*C*'. The compound '*C*' is

(a) $CH_3CH_2NH_2$
(b) $CH_3CH_2N\overset{\rightarrow}{\equiv}C$
(c) $CH_3C\equiv N$
(d) CH_3CH_2OH

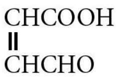
9. **Assertion :** *m*-Chlorobenzoic acid is a stronger acid than *p*-chlorobenzoic acid.

Reason : In *m*-chlorobenzoic acid, both –*I*-effect and +*R*-effect of Cl operate but in *p*-chlorobenzoic acid only +*R*-effect of Cl operates.

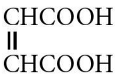
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

10. $C_6H_5NH_2 + A \longrightarrow C_6H_5NHCOCH{=}CHCOOH$

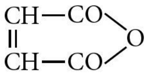
The compound *A* in the given reaction is

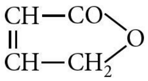
(a) 

$\begin{array}{l} CHCOOH \\ \| \\ CHCHO \end{array}$

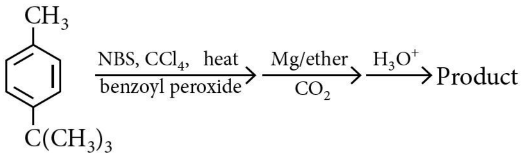
(b) 

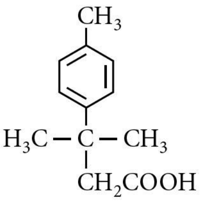
$\begin{array}{l} CHCOOH \\ \| \\ CHCOOH \end{array}$

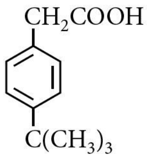
(c) 

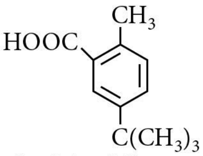
(d) 

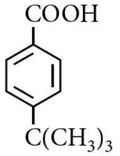
11. The final product of the following sequence of reactions is



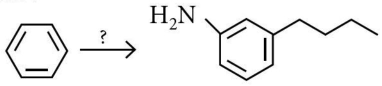
(a) 

(b) 

(c) 

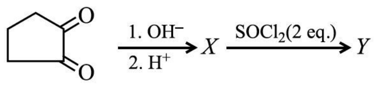
(d) 

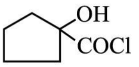
12. Which of the following reagents used for the given synthesis ?

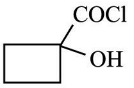


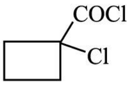
(a) (i) $C_4H_9Cl + AlCl_3$ (ii) HNO_3 + heat
(iii) $ZnCl_2/HCl$
(b) (i) $C_3H_7COCl + AlCl_3$ (ii) HNO_3 + heat
(iii) $ZnCl_2/HCl$
(c) (i) HNO_3 + heat (ii) $C_4H_9Cl + AlCl_3$
(iii) $ZnCl_2/HCl$
(d) (i) HNO_3 + heat (ii) $C_3H_7COCl + AlCl_3$
(iii) $ZnCl_2/HCl$

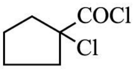
13. In the following sequence of reactions, find the product *Y*.



(a) 

(b) 

(c) 

(d) 

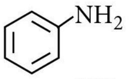
14. Which of the following will give a black precipitate on reaction with CS_2 followed by addition of $HgCl_2$?

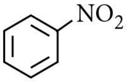
(a) $(CH_3)_2CNH_2$
(b) $(C_2H_5)_2NH$
(c) $(CH_3)_3N$
(d) All of these

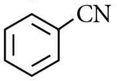
15. Aliphatic aldehydes react with Fehling's solution to give red ppt. but benzaldehyde does not produce red precipitate with Fehling's solution because

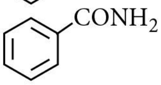
(a) of a bulky ring, —CHO is hindered
(b) of resonance, oxidation of benzaldehyde is difficult
(c) —CHO is present in cyclic structure
(d) of all of the above statements.

16. A given nitrogen containing aromatic compound '*A*' reacts with Sn/HCl, followed by HNO_2 to give an unstable compound '*B*'. '*B*', on treatment with phenol, forms a beautiful coloured compound '*C*' with the molecular formula, $C_{12}H_{10}N_2O$. The structure of compound '*A*' is

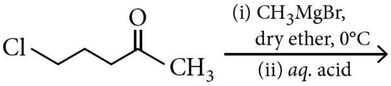
(a) 

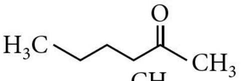
(b) 

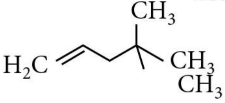
(c) 

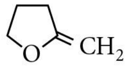
(d) 

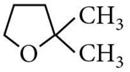
17. The major product in the following reaction is


Cl
O
CH_3
(i) CH_3MgBr, dry ether, 0°C
(ii) *aq.* acid

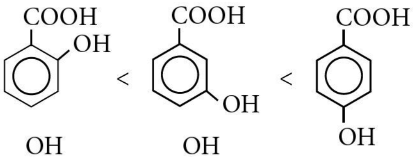
(a) 

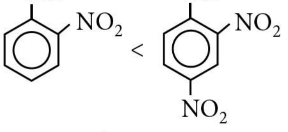
(b) 
H_2C
CH_3
CH_3
CH_3

(c) 

(d) 

18. Identify the incorrect order of acidic strength.

(a) 
COOH
OH
<
COOH
OH
<
COOH
OH

(b) 
OH
NO_2
<
OH
NO_2
NO_2

(c) HF < HCl < HBr < HI
(d) $HOCl < HClO_2 < HClO_3 < HClO_4$

19. Given below are two statements :

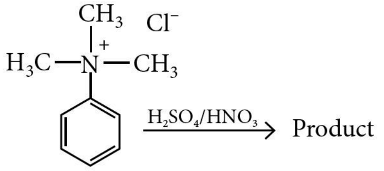
Statement I : The nucleophilic addition of sodium hydrogen sulphite to an aldehyde or a ketone involves proton transfer to form a stable ion.

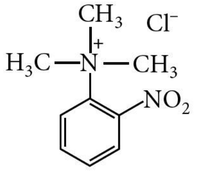
Statement II : The nucleophilic addition of hydrogen cyanide to an aldehyde or a ketone yields amine as final product.

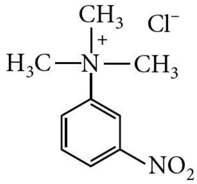
In the light of the above statements, choose the most appropriate answer from the options given below.

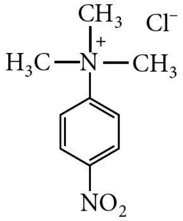
(a) Both statement I and statement II are false.
(b) Both statement I and statement II are true.
(c) Statement I is false but statement II is true.
(d) Statement I is true but statement II is false.

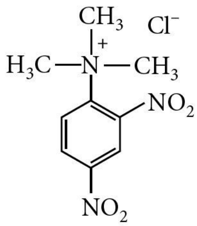
20. The product formed in the below reaction is


CH_3
Cl^-
H_3C
$\overset{+}{N}$
CH_3
H_2SO_4/HNO_3
Product

(a) 
CH_3
Cl^-
H_3C
$\overset{+}{N}$
CH_3
NO_2

(b) 
CH_3
Cl^-
H_3C
$\overset{+}{N}$
CH_3
NO_2

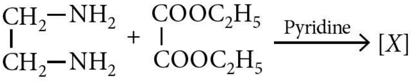
(c) 
CH_3
Cl^-
H_3C
$\overset{+}{N}$
CH_3
NO_2

(d) 
CH_3
Cl^-
H_3C
$\overset{+}{N}$
CH_3
NO_2
NO_2

NUMERICAL VALUE TYPE QUESTIONS

21. An organic compound *X* with molecular formula C_xH_yO (having minimum no. of C-atoms) on treatment with $K_2Cr_2O_7$ gives compound *Y* which reacts with I_2 and Na_2CO_3 to form triiodomethane. Then the value of $x \times y$ is _______.

22. In the given reacion (*X*) will contains number of carbon atoms in the major product is _________.



$$\begin{matrix} CH_2-NH_2 \\ | \\ CH_2-NH_2 \end{matrix} + \begin{matrix} COOC_2H_5 \\ | \\ COOC_2H_5 \end{matrix} \xrightarrow{\text{Pyridine}} [X]$$

23. Among the following, the number of reagents which convert aldehydes or ketones to alkanes is ______.

$NaBH_4$; NH_2NH_2, KOH; HI, red P; H_2, Ni; Zn/Hg, HCl; $LiAlH_4$; acidified $KMnO_4$; alkaline $KMnO_4$

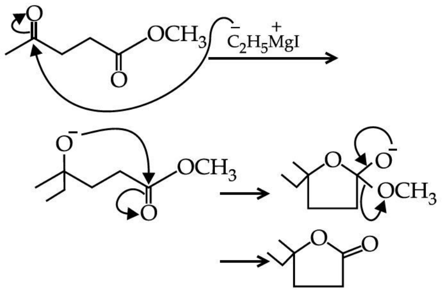
24. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y \xrightarrow[\text{anhydride}]{\text{Acetic}} Z$

If the molecular mass of '*Y*' is *a* and '*Z*' is *b*, then find the value of $\frac{a+b}{2}$.

25. A solution of phenol in chloroform when treated with aqueous NaOH gives compound *P* as a major product. The mass percentage of carbon in *P* is ____. (Nearest integer)
(Atomic mass : C = 12; H = 1; O = 16)

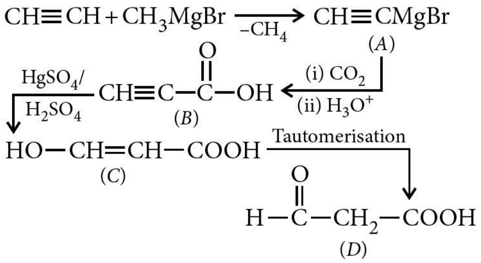
SOLUTIONS

1. (c) :


O
OCH3
C2H5MgI
O
O−
OCH3
O
O
O−
OCH3
O
O

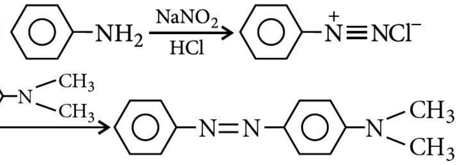
2. (b)

3. (b):



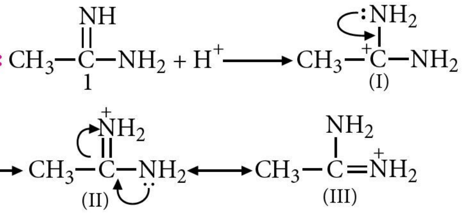
$$CH\equiv CH + CH_3MgBr \xrightarrow[-CH_4]{} \underset{(A)}{CH\equiv CMgBr} \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } CO_2} \underset{(B)}{CH\equiv C-\overset{O}{\overset{\|}{C}}-OH} \xrightarrow[H_2SO_4]{HgSO_4/} \underset{(C)}{HO-CH=CH-COOH} \xrightarrow{\text{Tautomerisation}} \underset{(D)}{H-\overset{O}{\overset{\|}{C}}-CH_2-COOH}$$

4. (b):


NH2
NaNO2
HCl
N≡NCl−
N
CH3
CH3
N=N
N
CH3
CH3

5. (d)

6. (b) :

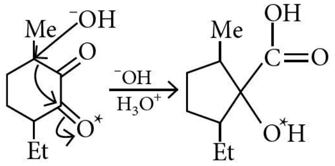


$$CH_3-\underset{1}{\overset{NH}{\overset{\|}{C}}}-NH_2 + H^+ \longrightarrow \underset{(I)}{CH_3-\overset{:NH_2}{\overset{|}{\overset{+}{C}}}-NH_2} \longleftrightarrow \underset{(II)}{CH_3-\overset{\overset{+}{N}H_2}{\overset{\|}{C}}-\ddot{N}H_2} \longleftrightarrow \underset{(III)}{CH_3-\overset{NH_2}{\overset{|}{C}}=\overset{+}{N}H_2}$$

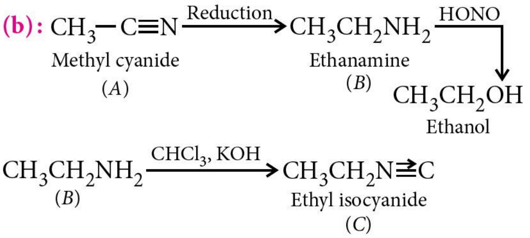
The conjugate acid (I) obtained by addition of a proton to (1) is stabilised by two equivalent resonating structures and hence, compound (1) is the most basic. Further 2° amines are more basic than 1° amines while amides are least basic due to delocalisation of lone pair of electrons of N over the C=O group. Thus, the order : 1 > 3 > 2 > 4.

7. (a) : This is an example of Benzil–Benzilic acid rearrangement reaction.

$^-$OH attacks at the more reactive (C = O) group, (containing more EWG or less EDG). Et is more EDG than Me (due to +*I* effect). Therefore, $^-$OH attacks C = O with Me group.


Me
−OH
O
O*
Et
−OH
H3O+
Me
OH
C=O
O*H
Et

8. (b):

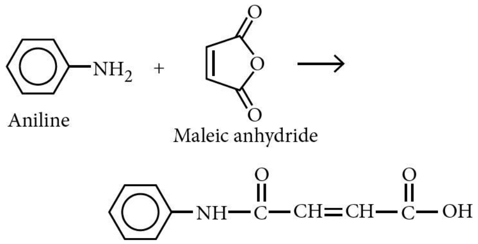


$$\underset{\substack{\text{Methyl cyanide}\\(A)}}{CH_3-C\equiv N} \xrightarrow{\text{Reduction}} \underset{\substack{\text{Ethanamine}\\(B)}}{CH_3CH_2NH_2} \xrightarrow{HONO} \underset{\text{Ethanol}}{CH_3CH_2OH}$$

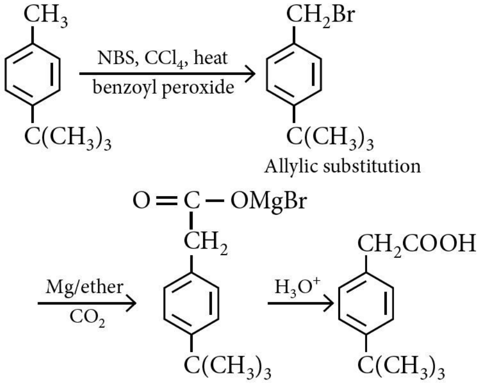
$$\underset{(B)}{CH_3CH_2NH_2} \xrightarrow{CHCl_3,\ KOH} \underset{\substack{\text{Ethyl isocyanide}\\(C)}}{CH_3CH_2N\equiv C}$$

9. (c)

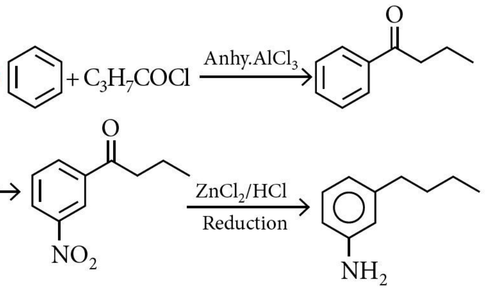
10. (c) :


NH2
Aniline
O
O
O
Maleic anhydride
O
O
NH—C—CH=CH—C—OH

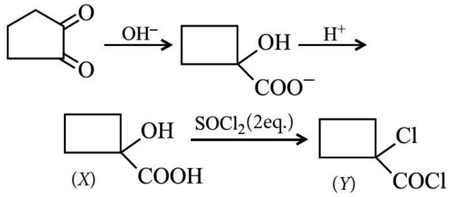
11. (b):


CH3
C(CH3)3
NBS, CCl4, heat
benzoyl peroxide
CH2Br
C(CH3)3
Allylic substitution
O=C−OMgBr
CH2
Mg/ether
CO2
C(CH3)3
H3O+
CH2COOH
C(CH3)3

12. (b):


+ C3H7COCl
Anhy.AlCl3
O
HNO3
Δ
O
NO2
ZnCl2/HCl
Reduction
NH2

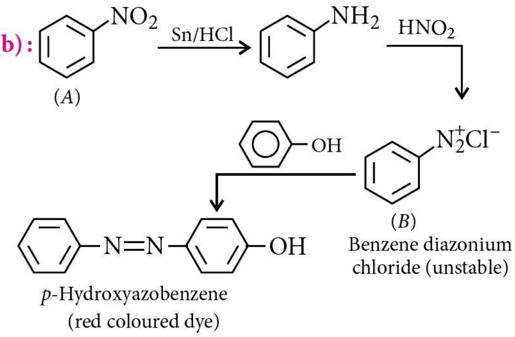
13. (c) : 1st reaction is benzilic acid rearrangement.


OH⁻
OH
COO⁻
H⁺
OH
SOCl₂(2eq.)
Cl
(X)
COOH
(Y)
COCl

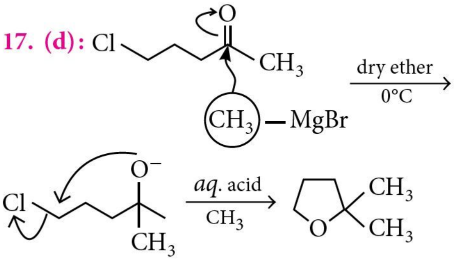
14. (a)

15. (b): Resonance gives rise to stability in molecule.

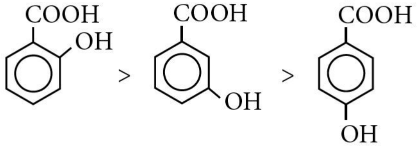
16. (b):


NO₂
Sn/HCl
NH₂
HNO₂
(A)
OH
N₂⁺Cl⁻
N=N
OH
(B)
Benzene diazonium chloride (unstable)
p-Hydroxyazobenzene (red coloured dye)

17. (d):


Cl
O
CH₃
dry ether
0°C
CH₃ — MgBr
O⁻
Cl
aq. acid
CH₃
CH₃
CH₃
O
CH₃

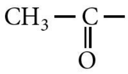
18. (a) : The correct order of acidic strength is :

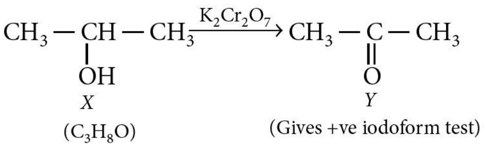

COOH
OH
>
COOH
OH
>
COOH
OH

19. (d)

20. (b): As nitrogen is positively charged, thus it will act as electron withdrawing group so it will deactivate the benzene ring and will be *meta*-directing.

21. (24) : As Y gives positive iodoform test so Y could be any ketone with $CH_3-\underset{\overset{\|}{O}}{C}-$ group, with minimum carbon atoms it could be acetone only.





$$\underset{\substack{X \\ (C_3H_8O)}}{CH_3-\underset{\overset{|}{OH}}{CH}-CH_3} \xrightarrow{K_2Cr_2O_7} \underset{\substack{Y \\ \text{(Gives +ve iodoform test)}}}{CH_3-\underset{\overset{\|}{O}}{C}-CH_3}$$

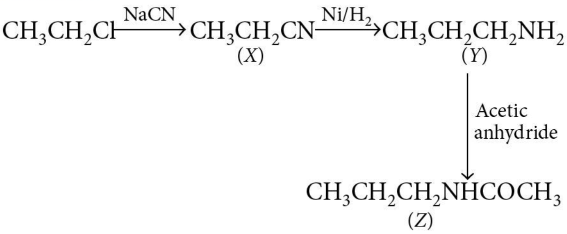
∴ $x = 3$; $y = 8$

∴ $xy = (3 \times 8) = 24$

22. (4)

23. (3): NH_2NH_2, KOH; HI, red P; Zn/Hg, HCl

24. (80) :



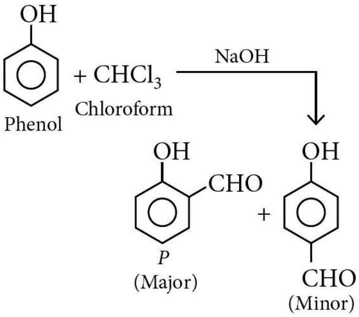
$$\begin{tikzcd} CH_3CH_2Cl \arrow[r, "NaCN"] & \underset{(X)}{CH_3CH_2CN} \arrow[r, "Ni/H_2"] & \underset{(Y)}{CH_3CH_2CH_2NH_2} \arrow[d, "\text{Acetic anhydride}"] \\ & & \underset{(Z)}{CH_3CH_2CH_2NHCOCH_3} \end{tikzcd}$$

Molecular mass of Y, C_3H_9N is 59 and molecular mass of Z, $C_5H_{11}NO$ is 101.

∴ $a = 59$; $b = 101$

$$\frac{a+b}{2} = \frac{59+101}{2} = \frac{160}{2} = 80.$$

25. (69) :


OH
Phenol
+ CHCl₃
Chloroform
NaOH
OH
CHO
P
(Major)
+
OH
CHO
(Minor)

Molecular formula of major product, $P = C_7H_6O_2$

Molar mass of product, $P = (7 \times 12 + 6 \times 1 + 16 \times 2)$

$= 122$ g/mol

∴ The mass percentage of carbon in $P = \frac{84}{122} \times 100$

$= 68.85\% \approx 69\%$

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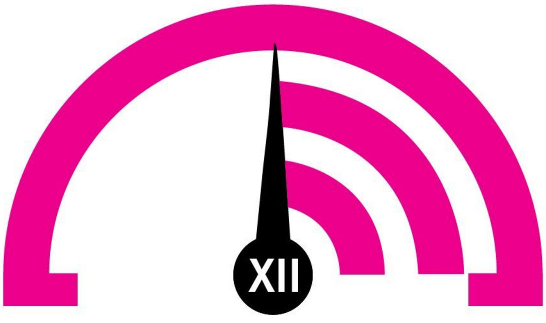


This specially designed column enables students to self analyse their extent of understanding the specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

The *d*- and *f*- Block Elements | Coordination Compounds

Time Taken : 60 Min.

NEET

Only One Option Correct Type

1. Amongst TiF_6^{2-}, CoF_6^{3-}, Cu_2Cl_2 and $NiCl_4^{2-}$ (At. nos. of Ti = 22, Co = 27, Cu = 29, Ni = 28), the colourless species are
(a) CoF_6^{3-} and $NiCl_4^{2-}$ (b) TiF_6^{2-} and CoF_6^{3-}
(c) Cu_2Cl_2 and $NiCl_4^{2-}$ (d) TiF_6^{2-} and Cu_2Cl_2

2. Increasing order of Δ_o of the following complexes is
(a) $[Cr(NH_3)_6]^{3+} < [Cr(H_2O)_6]^{3+} < [Cr(NO_2)_6]^{3-}$
(b) $[Cr(H_2O)_6]^{3+} > [Cr(NH_3)_6]^{3+} > [Cr(NO_2)_6]^{3-}$
(c) $[Cr(H_2O)_6]^{3+} < [Cr(NH_3)_6]^{3+} < [Cr(NO_2)_6]^{3-}$
(d) $[Cr(NH_3)_6]^{3+} < [Cr(NO_2)_6]^{3-} < [Cr(H_2O)_6]^{3+}$

3. Which of the following will dissolve in excess of ammonia?
(a) AgI (b) AgBr
(c) AgCl (d) None of these

4. Which of the following complex ions is diamagnetic?
(a) $[FeF_6]^{3-}$ (b) $[CoF_6]^{3-}$
(c) $[Co(C_2O_4)_3]^{3-}$ (d) $[Fe(CN)_6]^{3-}$

5. In an octahedral crystal field, the t_{2g} orbitals are
(a) raised in energy by 0.4 Δ_o
(b) lowered in energy by 0.4 Δ_o
(c) raised in energy by 0.6 Δ_o
(d) lowered in energy by 0.6 Δ_o

6. Which one of the following has the least magnetic moment?
(a) Cu^{2+} (b) Ni^{2+} (c) Co^{2+} (d) Fe^{2+}

7. Which one of the following is the correct order of field strength of ligands in spectrochemical series?
(a) $I^- < Cl^- < F^- < H_2O < CN^-$
(b) $F^- < H_2O < I^- < CN^- < Cl^-$
(c) $CN^- < I^- < F^- < Cl^- < H_2O$
(d) $H_2O < F^- < CN^- < Cl^- < I^-$

8. Most of the transition metals exhibit
(i) paramagnetic behaviour
(ii) diamagnetic behaviour
(iii) variable oxidation states
(iv) coloured complexes.
(a) (ii), (iii) and (iv) (b) (i), (iii) and (iv)
(c) (i), (ii) and (iii) (d) (i), (ii) and (iv)

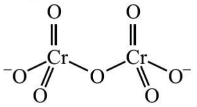
9. Which of the following statements is correct about stability of the complexes of lanthanoids?
(a) Stability of complexes increases as the size of lanthanoid decreases.
(b) Stability of complexes decreases as the size of lanthanoid decreases.
(c) Lanthanoids do not form complexes.
(d) All the complexes of lanthanoids have the same stability.

10. What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?
(a) Cr^{3+} and $Cr_2O_7^{2-}$ are formed.
(b) $Cr_2O_7^{2-}$ and H_2O are formed.
(c) CrO_4^{2-} is reduced to +3 state of Cr.
(d) CrO_4^{2-} is oxidised to +7 state of Cr.

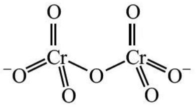
11. More number of oxidation states are exhibited by actinoids than lanthanoids. The main reason for this is
(a) greater metallic character of lanthanoids than that of their corresponding actinoids
(b) more active nature of actinoids
(c) more energy difference between 5*f* and 6*d* orbitals than that between 4*f* and 5*d* orbitals
(d) lesser energy difference between 5*f* and 6*d* orbitals than that between 4*f* and 5*d* orbitals.

12. Identify the correct structure of dichromate ion.

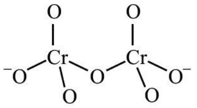
(a)



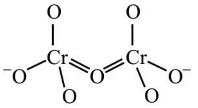
(b)



(c)



(d)



Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Copper(II) iodide is not known.
Reason : Cu^{2+} oxidises I^- to I_2.

14. **Assertion :** According to crystal field theory, during the formation of an octahedral complex, the *d*-orbitals split and form two sets of orbitals t_{2g} and e_g.
Reason : Splitting of *d*-orbitals occurs only in case of strong field ligands.

15. **Assertion :** Ce^{4+} is a good analytical reagent.
Reason : Ce^{4+} has the tendency to change to Ce^{3+}.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. The lanthanide ion that would show colour is
(a) Lu^{3+} (b) Sm^{3+} (c) La^{3+} (d) Gd^{3+}

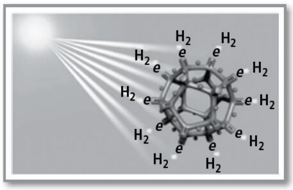
17. An explosion takes place when conc. H_2SO_4 is added to $KMnO_4$. Which of the following is formed?
(a) Mn_2O_7 (b) MnO_2 (c) $MnSO_4$ (d) Mn_2O_3

18. Which of the following complexes will have four isomers?
(a) $[Co(en)(NH_3)_2Cl_2]Cl$
(b) $[Co(PPh_3)_2(NH_3)_2Cl_2]Cl$
(c) $[Co(en)_3]Cl_3$ (d) $[Co(PPh_3)_3Cl]Cl_2$

19. Arrange the following metal complex compounds in the increasing order of spin only magnetic moment. Assume all the three complexes have high spin system.
(Atomic numbers Ce = 58, Gd = 64 and Eu = 63)
(A) $(NH_4)_2[Ce(NO_3)_6]$ (B) $Gd(NO_3)_3$ and
(C) $Eu(NO_3)_3$
(a) (C) < (A) < (B) (b) (B) < (A) < (C)
(c) (A) < (C) < (B) (d) (A) < (B) < (C)

Chemistry bulletin

'Game-changing' findings for sustainable hydrogen production



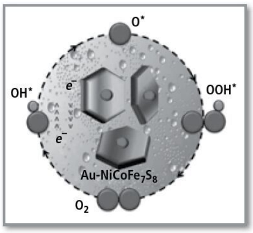
Hydrogen fuel could be a more viable alternative to traditional fossil fuels according to University of Surrey researchers who have found that a type of metal-free catalysts could contribute to the development of cost-effective and sustainable hydrogen production technologies.

The study has shown promising results for the use of edge-decorated nano carbons as metal-free catalysts for the direct conversion of methane, which is also a powerful greenhouse gas, into hydrogen. Among the nano carbons investigated, nitrogen-doped nano carbons presented the highest level of performance for hydrogen production at high temperatures.

Crucially, the researchers also found that the nitrogen-doped and phosphorus-doped nano carbons had strong resistance to carbon poisoning, which is a common issue with catalysts in this process.

Dr Neubi Xavier Jr, the Research Fellow who performed the material science simulations, said:

"Our results suggest that using edge-decorated nano carbons as catalysts could be a game-changer for the hydrogen industry, offering a cost-effective and sustainable alternative to traditional metal catalysts. At the same time, this process gets rid of methane, which is a fossil fuel involved in global warming."



Hydrogen fuel is a clean and renewable energy source that has the potential to reduce carbon emissions and decrease our dependence on fossil fuels. When used as a fuel, hydrogen can power vehicles, generate electricity, and heat buildings. The only by-product of hydrogen fuel is water vapour, making it an environmentally friendly alternative to traditional fossil fuels.

However, the production of hydrogen fuel is currently reliant on fossil fuels, which creates carbon emissions in the process, and metal catalysts, which mining and manufacturing are energy intensive and can negatively affect the environment. Therefore, the development of sustainable hydrogen production methods and catalytic materials is crucial to realising the full potential of hydrogen fuel as a clean energy source.

The research was conducted by a team led by Dr Marco Sacchi from the University of Surrey. Dr Sacchi said:

"One of the biggest challenges with catalysts for hydrogen production is that they can get poisoned by carbon. But our study found that nitrogen and phosphorus-doped nano carbons are pretty resistant to this problem. This is a huge step forward for sustainable hydrogen production."

More than One Option Correct Type

20. Reduction of the metal centre in aqueous permanganate ion involves
(a) 3 electrons in neutral medium
(b) 5 electrons in neutral medium
(c) 3 electrons in weakly alkaline medium
(d) 5 electrons in acidic medium.

21. Optical isomerism is exhibited by (*ox* = oxalate anion, *en* = ethylenediamine)
(a) *cis*-$[CrCl_2(ox)_2]^{3-}$ (b) $[Co(en)_3]^{3+}$
(c) *trans*-$[CrCl_2(ox)_2]^{3-}$ (d) $[Co(en)_2Cl_2]^+$

22. Potassium manganate (K_2MnO_4) is formed when
(a) chlorine is passed into aqueous $KMnO_4$ solution
(b) manganese dioxide is fused with potassium hydroxide in air
(c) formaldehyde reacts with potassium permanganate in presence of a strong alkali
(d) potassium permanganate reacts with concentrated sulphuric acid.

23. The compounds that exhibit geometrical isomerism are
(a) $[Pt(en)Cl_2]$ (b) $[Pt(en)_2]Cl_2$
(c) $[Pt(en)_2Cl_2]Cl_2$ (d) $[Pt(NH_3)_2Cl_2]$

Integer / Numerical Value Type

24. A square planar complex of type M_{AXBL} (where *A*, *B*, *X* and *L* are unidentate ligands) has *x cis* isomers and *y trans* isomers. The total number (sum of *x* + *y*) isomers possessed by the complex is ________.

25. $[Ti(H_2O)_6]^{3+}$ absorbs light of wavelength 498 nm during a *d*-*d* transition. The octahedral splitting energy for the above complex is ________ $\times 10^{-19}$ J.
($h = 6.626 \times 10^{-34}$ J s; $c = 3 \times 10^8$ m s^{-1}).

26. The magnetic moment of the complex $[NiCl_4]^{2-}$ in B.M. is ________.

Comprehension Type Questions

The splitting of the degenerate levels due to the presence of ligands in a definite geometry is known as crystal field splitting. The crystal field splitting is measured in terms of energy difference between t_{2g} and e_g orbitals and is denoted by Δ_o. The e_g orbitals are 0.6 Δ_o above the average energy level and the t_{2g} orbitals are 0.4 Δ_o below the average energy level.

27. In which of the following octahedral complexes of Co (At. no. 27), will the magnitude of Δ_o be the highest?
(a) $[Co(NH_3)_6]^{3+}$ (b) $[Co(CN)_6]^{3-}$
(c) $[Co(C_2O_4)_3]^{3-}$ (d) $[Co(H_2O)_6]^{3+}$

28. Identify the correct trend given below :
(Atomic no. : Ti = 22, Cr = 24 and Mo = 42)
(a) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and
Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$
(b) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and
Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$
(c) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and
Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$
(d) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and
Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

Matching Type

29. Match the column-I with column-II and select the correct option.

Column-I (Conductance)		Column-II (Formula)	
(A)	229	(i)	$[Pt(NH_3)_5Cl]Cl_3$
(B)	97	(ii)	$[Pt(NH_3)_3Cl_3]Cl$
(C)	404	(iii)	$[Pt(NH_3)_4Cl_2]Cl_2$
(D)	523	(iv)	$[Pt(NH_3)_6]Cl_3$

(a) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)
(b) (A) → (i), (B) → (iv), (C) → (iii), (D) → (ii)
(c) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
(d) (A) → (iii), (B) → (ii), (C) → (i), (D) → (iv)

30. Match the column-I with column-II and select the correct option.

Column-I (Catalyst)		Column-II (Process)	
(A)	$TiCl_4$	(i)	Wacker process
(B)	$PdCl_2$	(ii)	Ziegler-Natta polymerization
(C)	$CuCl_2$	(iii)	Contact process
(D)	V_2O_5	(iv)	Deacon's process

(a) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)
(b) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)
(c) (A) → (iii), (B) → (ii), (C) → (iv), (D) → (i)
(d) (A) → (ii), (B) → (i), (C) → (iv), (D) → (iii)

◆◆

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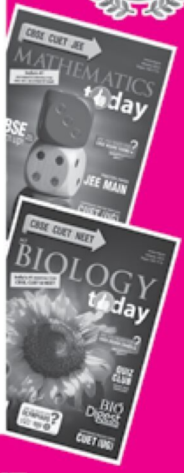

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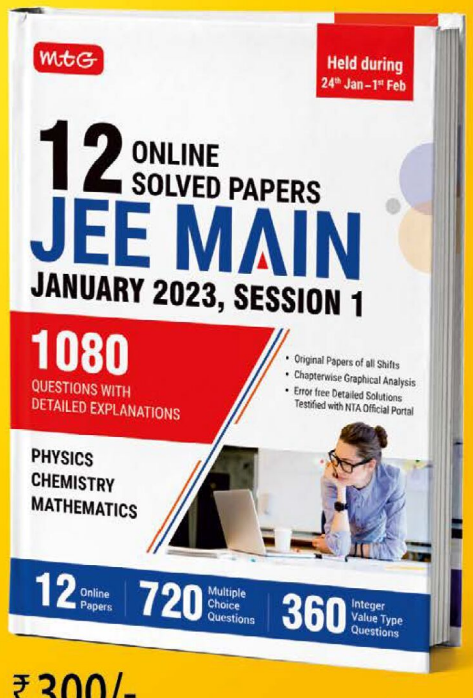
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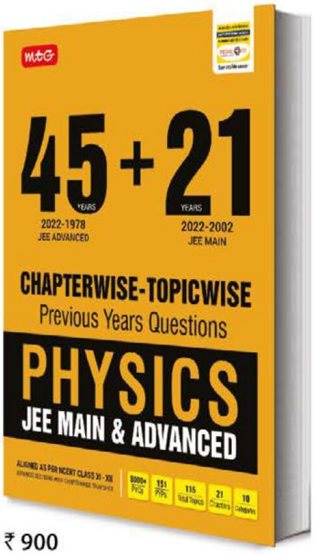
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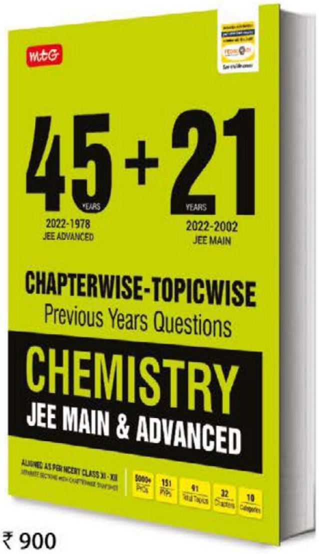
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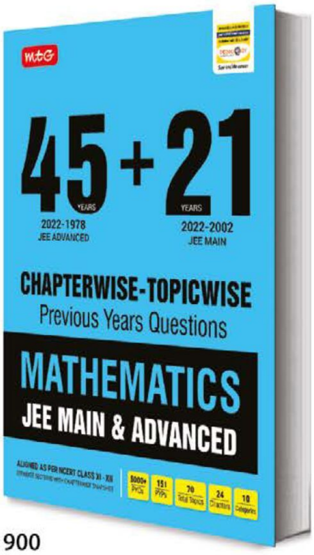
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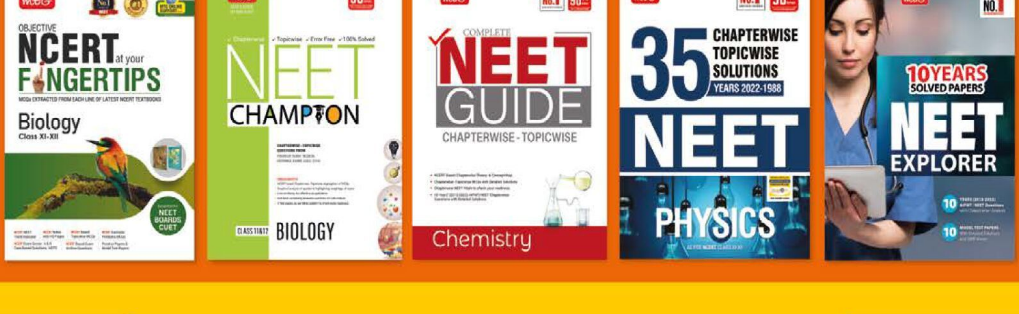
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